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RESEARCH ON GENERAL VOCATIONAL CAPABILITIES (SKILLS AND KNOWLEDGES). FINAL REPORT.

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DESCRIPTORS- *EDUCATIONAL RESEARCH, *JOB SKILLS, *VOCATIONAL EDUCATION, SECONDARY EDUCATION, POST SECONDARY EDUCATION, *CURRICULUM, *OCCUPATIONS, RELATIONSHIP, SEX (CHARACTERISTICS), TASK PERFORMANCE, WOODS COUNTY, WEST VIRGINIA, QUINCY, MASSACHUSETTS,

THE OBJECTIVES WERE TO (1) DEVELOP AND VERIFY METHODS FOR DETERMINING GENERAL CAPABILITIES REQUIRED FOR JOBS, (2) DESCRIBE THE GENERAL VOCATIONAL CAPABILITIES OF HIGH SCHOOL STUDENTS AND RELATE THEM TO INTELLECTUAL APTITUDES AND EDUCATIONAL EXPERIENCE, AND (3) DERIVE EDUCATIONAL IMPLICATIONS FROM AN ANALYSIS OF THESE GENERAL VOCATIONAL CAPABILITIES. TASK BEHAVIORS FOR EACH OF 31 OCCUPATIONS HAVING MAJOR EMPLOYMENT OPPORTUNITIES IN THE FUTURE WERE TRANSLATED INTO MULTIPLE CHOICE TEST ITEMS. THE ITEMS, RATIONALLY ORGANIZED INTO A SET OF TESTS RESULTING IN A TOTAL OF 24 TESTS, WERE ADMINISTERED TO ABOUT 10,000 STUDENTS FROM GRADE 9 THROUGH JUNIOR COLLEGE IN THE WOODS COUNTY (PARKERSBURG), WEST VIRGINIA AND QUINCY, MASSACHUSETTS SCHOOL SYSTEMS. ANALYSES WERE PERFORMED FOR GIRLS AND BOYS SEPARATELY AND FOR THE COMBINED GROUP. SCORES OF ALL TESTS FOR EACH OCCUPATION WERE ANALYZED IN TERMS OF RELATIVE MALE VERSUS FEMALE MEAN PERFORMANCE. ONE OF THE MAJOR FINDINGS WAS THAT THERE IS A DEFINABLE AND WELL-STRUCTURED DOMAIN OF VOCATIONAL CAPABILITIES WHICH HAS NOT PREVIOUSLY BEEN WELL DEFINED AND WHICH IS NOT BEING SYSTEMATICALLY TAUGHT BY EDUCATIONAL INSTITUTIONS. THIS DOMAIN PROMISES TO ENHANCE THE FLEXIBILITY WITH WHICH STUDENTS CAN APPLY THE RESULTS OF THEIR EDUCATIONAL EXPERIENCES. THE APPENDIX INCLUDES SAMPLES OF PRODUCTS FROM INTERIM STAGES OF THE PROJECT AND SOME OF THE DETAILED STATISTICAL RESULTS. (SL)

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RESEARCH ON GENERAL VOCATIONAL CAPABILITIES (SKILLS AND KNOWLEDGES)

(FINAL REPORT)

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TABLE OF CONTENTS

Page

ACKNOWLEDGMENTS . . . i
LIST OF TABLES . . . v
LIST OF FIGURES . . . ix
SUMMARY . . . xi
INTRODUCTION . . . 1
    Problem . . . 1
    Objectives and Limitations . . . 3
    Definitions . . . 5
    Audience . . . 6
    Overview . . . 6
APPROACH . . . 9
    Summary . . . 9
    Selection of Occupations . . . 9
    Occupational Description . . . 11
        General Occupational Description . . . 12
        Task Enumeration . . . 13
        Task Description . . . 15
    Selection of Measurable Behaviors . . . 17
        Some Earlier Approaches . . . 18
        A Way of Viewing Behavior . . . 21
        Selection of Actions . . . 23
        Deriving Measurable Behaviors . . . 23
        Describing and Analyzing Measurable Behaviors . . . 24
        Translating Behaviors into Items . . . 25
    Analysis of Performance Data . . . 27
        Some Available Techniques . . . 27
        Performance Analysis for the Current Study . . . 30
GENERAL RESULTS . . . 33
    Basic Vocational Capabilities in the Educational Process . . . 33
    The Structure of General Vocational Capabilities . . . 35
        Sex Differences . . . 35
        Correlational Patterns . . . 39
        Vocational Capabilities and Intelligence . . . 45
        School Courses and Intelligence . . . 46
        Generalization of Capabilities to New Occupations . . . 47
        Missing Capabilities . . . 47
        Occupational "Universals" . . . 47
MECHANICAL . . . 49
ELECTRICAL . . . 53
SPATIAL . . . 55
CHEMICAL-BIOLOGICAL . . . 59
SYMBOLIC . . . 63
PEOPLE . . . 67
PSYCHOLOGICAL PROCESSES . . . 71
A GENERAL CAPABILITIES DOMAIN . . . 77

IMPLICATIONS 83
    Curriculum Implications 83
        Missing: Basic Job Technology 83
        A Bridge between Career Planning and Specific Job Training 84
        A Compatible Opportunity 84
        A Feasible Objective 85
        A Controllable Phenomenon 85
        Skimming the Cream 86
        Learning Sequence 86
    Methodological Implications 86
        Job Similarity Analysis 86
        Job and Task Description Techniques 87
        Classification of Specific Job Behaviors 87
        Programming by Content and Psychological Process . . . 88
        Behavior Simulation and Correlational Analysis 88
        Experimental Studies of Generalization 88
    Theoretical Implications 89
        Aptitudes 89
        Proficiency 89
        Human Development 90
        Interest and Motivation 90
APPENDIX 91
REFERENCES 149

LIST OF TABLES

Page

Table 1. Stability of Career Choice for High School Students . . 2

Table 2. Relatedness of First Jobs for Vocational Graduates (All Males) 2

Table 3. Fine's Orders of Similarity 28

Table 4. Intercorrelations of Major Areas of General Vocational Capabilities for 12th Grade Students 40

Table 5. Intercorrelations of Major Areas of General Vocational Capabilities for Students from 9th Grade through Junior College 41

Table 6. Obtained Correlations between Tests, Ordered by a Hardware-People Continuum 43

Table 7. Proportions of Variance in Common (r^2) between Tests (Corrected for Attenuation) Ordered by a Hardware-People Continuum 44

Table 8. Correlations between Aptitude Scores and Major Areas of General Vocational Capability 46

Table 9. General Structure for Machines and Mechanical Principles 50

Table 10. Electrical Principles 54

Table 11. Spatial Relationships and Principles 56

Table 12. Chemical and Biological Principles 60

Table 13. Numerical Operations 64

Table 14. Verbal Communication 65

Table 15. Human Relations 68

Table 16. Psychological Processes with Related Categories of Learning and Characteristic Errors 73

Table 17. Sample Behaviors for Each Psychological Process--Content Area Combination 79

Table 18. Occupations Judged to Have Relatively Few Employment Opportunities 91

Table 19. Occupations Rated as Having Many and a Moderate Number of Opportunities over the Next Decade, with Worker Functions Contained in Each 92

Table 20. Occupations Rated as Having Many and a Moderate Number of Opportunities over the Next Decade, with the Major Industries to which Each Pertains 93

Table 21. Sample Population Definition for Welder 94

Table 22. Sample Mission Statements 95

Table 23. Sample Functions for Practical Nurse 96

Table 24. Sample Contingencies and Contexts Faced by a Truck Driver 97

Table 25. Sample Enumeration of Tasks for Truck Driver 98

Table 26. Sample Task Description for Practical Nurse 99
Table 27. Sample Task Descriptions for Sheet Metal Worker 106
Table 28. Sample Tasks for Computer Programmer 109
Table 29. Types of Psychological Processes and Testing Implications 111
Table 30. Types of Responses and Testing Implications 112
Table 31. Format for Analysis of Measurable Behaviors 113
Table 32. Examples of Kinds of Items which Appear in Tests to Establish General Vocational Capabilities 114
Table 33. Mean Sex Differences on Original Occupational Tests . . 115
Table 34. Mean Sex Differences for Seniors 116
Table 35. Mean Sex Differences for Ninth Grade through Junior College 117
Table 36. Obtained Correlations between Capabilities Tests for Students from 9th Grade through Junior College . . 118
Table 37. Obtained Correlations between Tests, Ordered by Degree of Sex Differences 119
Table 38. Proportions of Variance in Common (r^2) between Tests (Corrected for Attenuation) Ordered by Degree of Sex Difference 120
Table 39. Observed Minus Expected Proportions of Variance (Corrected for Attenuation) in Common between Tests, Ordered by Degree of Sex Difference 121
Table 40. Correlations between Aptitude and General Vocational Capability Test Scores 122
Table 41. Relationships of Linguistic Aptitude Test with School Courses (High School Seniors) 123
Table 42. Relationships of Quantitative Aptitude Test with School Courses (High School Seniors) 124
Table 43. Relationships of Tools with School Courses (High School Seniors) 125
Table 44. Relationships of Mechanical Systems with School Courses (High School Seniors) 126
Table 45. Relationships of Measuring Instruments with School Courses (High School Seniors) 127
Table 46. Relationships of Stationary Equipment Operation with School Courses (High School Seniors) 128
Table 47. Relationships of Vehicular Operation with School Courses (High School Seniors) 129
Table 48. Relationships of Connections and Fittings with School Courses (High School Seniors) 130
Table 49. Relationships of Fluid Systems with School Courses (High School Seniors) 131
Table 50. Relationships of Electricity with School Courses (High School Seniors) 132
Table 51. Relationships of Layout and Visualization with School Courses (High School Seniors) 133
Table 52. Relationships of Structures with School Courses (High School Seniors) 134

Table 52. Relationships of Structures with School Courses (High School Seniors) 134
Table 53. Relationships of Materials with School Courses (High School Seniors) 135
Table 54. Relationships of Chemicals with School Courses (High School Seniors) 136
Table 55. Relationships of Foods and Cooking with School Courses (High School Seniors) 137
Table 56. Relationships of Biological Systems with School Courses (High School Seniors) 138
Table 57. Relationships of Medical and First Aid with School Courses (High School Seniors) 139
Table 58. Relationships of Arithmetic Conventions with School Courses (High School Seniors) 140
Table 59. Relationships of Clerical with School Courses (High School Seniors) 141
Table 60. Relationships of Computing with School Courses (High School Seniors) 142
Table 61. Relationships of Sales with School Courses (High School Seniors) 143
Table 62. Relationships of Dealing with Situations with School Courses (High School Seniors) 144
Table 63. Relationships of Service with School Courses (High School Seniors) 145
Table 64. Relationships of Etiquette with School Courses (High School Seniors) 146
Table 65. Relationships of Style and Grooming with School Courses (High School Seniors) 147
Table 66. Relationships of Garment Equipment Operation with School Courses (High School Seniors) 148

LIST OF FIGURES

Page

Figure 1. The Place of General Vocational Capability Development . 34

Figure 2. Male Versus Female Superiority for the 31 Occupations Tested--All Grades Combined 36

Figure 3. A Pattern of General Vocational Capabilities for 12th Grade Students 37

Figure 4. A Pattern of General Vocational Capabilities for a Composite of 9th Grade through Junior College Students . 38

Figure 5. Hypothesized Inclusion Relationships among Psychological Processes 76

SUMMARY

Increasing rates of technological improvement and social change demand graduates with capabilities (skills and knowledge) which are generalizable across a reasonable variety of job requirements for the present and future. The American Institutes for Research (AIR) conducted a study of general vocational capabilities under a grant from the Ford Foundation. The two main objectives of the study were to:

1. Describe, insofar as a study of students under existing educational programs will warrant, a domain of general vocational capabilities.
2. Suggest methodological improvements in the derivation of educational goals for general vocational capabilities.

A sample of 31 occupations was drawn which had major employment opportunities over the coming decade. These occupations, selected jobs within each occupational group, and their component tasks were described. A random sample of task behaviors was drawn for each occupation. Each selected behavior was translated into a multiple-choice test item.

Tests for each occupation were administered to about 10,000 students in two separate school systems from ninth grade through junior college. Test scores were correlated and factor analyzed, but no clear and meaningful factor structure emerged. However, analysis of mean sex differences on the different tests suggested that the vocational content might be ordered along some underlying continuum such as hardware-to-people. Based on the assumption of such a continuum, 24 capabilities tests were defined on rational grounds. Each item was assigned to one of the rationally defined tests on a judgmental basis. These newly defined tests were then scored and correlated.

After a series of analyses of correlational patterns and mean sex differences, the following ordering of areas and tests emerged (a computing test was eliminated as being too elementary and a garment equipment operations test was eliminated as being too specific):

Areas	Tests
MECHANICAL	Tools Mechanical Systems Measurement and Measuring Instruments Stationary Equipment Operation Vehicular Operation Connections and Fittings Fluid Systems
ELECTRICAL	Electricity
SPATIAL	Layout and Visualization Structures
CHEMICAL-BIOLOGICAL	Materials Chemicals Foods and Cooking Biological Systems Medical and First Aid
SYMBOLIC	Arithmetic Conventions Clerical
PEOPLE (human relations)	Sales Dealing with Situations Service Etiquette Style and Grooming

Correlations between area scores and between test scores revealed a very strong tendency for areas and tests close together in this ordering to be much more related than areas or tests far from each other in this ordering. This suggests a relatively well-structured domain of general vocational capabilities as defined by these tests.

Correlations of linguistic and quantitative aptitude tests with the general capabilities tests were moderate, suggesting that more than general intelligence was measured with the capabilities tests.

Relationships of capabilities tests with different courses generally supported the notion of a spectrum of vocational capabilities defined by a hardware-to-people continuum. Students with superior experience and performance in physical sciences, shop courses, and drafting scored better on tests toward the hardware end, but these courses tended to lose their association with test performance toward the human relations end. Biology, languages, and social studies assumed a higher degree of relationship to tests toward the human end of the test array.

Content categories along the hardware-to-people continuum were found to be highly compatible with a cross-cutting set of psychological processes arranged in a hierarchy of complexity--sensing, detecting, rote sequencing (chaining), discriminating or identifying, coding, classifying, discrete estimating, continuous tracking, logical manipulation, rule using, decision making, and problem solving. These processes are associated with characteristic kinds of error possibilities and conditions of learning. They imply educational objectives and conditions for learning.

The most important implication of the study was that there is a definable and well-structured domain of vocational capabilities which has not previously been well defined and which is not being systematically taught by our educational institutions. This domain is compatible with and intimately related to existing academic disciplines and specialized vocational training. It can be a focal point for the development of vocational awareness, vocational choice, and career planning. If properly exploited, it also promises to enhance the flexibility with which students can apply the results of their educational experiences.

INTRODUCTION

Problem

Vocational education is faced with serious difficulties in any attempt to be effective in modern society.

- Vocational education is caught in a dilemma. On the one hand, vocational training is criticized for not providing the specific job skills that would preclude the necessity for special post-employment training, long periods of apprenticeship, and extensive job experience before a reasonable level of job proficiency is achieved. On the other hand, vocational education, which is too job specific, may produce graduates who are only narrowly competent and thus unable to make a suitable choice among employment opportunities.
- Increasing rates of technological improvement, which result in rapidly changing jobs, demand vocational graduates with skills and knowledge which are generalizable among a reasonable variety of jobs of today and tomorrow. This requirement for breadth and flexibility exists against a backdrop of ". . .far-reaching changes induced by technological advance in the relationship between man, his education, and his work" (Venn, 1964).
- The problem of providing appropriate vocational capabilities is complicated by the relative instability of career choice by high school students. Project TALENT results for students who indicated their career plans in 1960 show the following percentages of identical career choice when the individual was contacted one year following high school graduation (Flanagan, 1965):

Table 1

Stability of Career Choice for High School Students

Grade of the Individual when Initial Choice was Indicated	Males	Females
9	19%	27%
10	22%	31%
11	29%	37%

The relatively higher stability of females resulted primarily from the preponderance and stability of choices in the fields of nurse, teacher and librarian, office worker, and housewife. Career choices of female students in other areas tended to be substantially less stable.

- Even when individuals receive a course of high school instruction in a specific vocational area, there is no assurance that they will use the specific job training. Thus, a recent study indicates the following degrees of correspondence (as indicated by the graduate) between trade training and initial job placement (Eninger, 1965):

Table 2

Relatedness of First Jobs for Vocational Graduates (All Males)

Relation of First Job to Trade Training	Type of High School			
	Vocational		Comprehensive	
	Number	Percentage	Number	Percentage
Same Trade	763	33.6	355	23.9
Highly Related Trade	447	19.7	244	16.5
Slightly Related Trade	311	13.7	233	15.7
Completely Unrelated Trade	751	33.1	651	43.9

- Effective education for occupations depends upon more than the accumulation of skill and knowledge after a career has been chosen and plans for its achievement formulated. The process of choosing a career ". . .ideally consists of several complex elements. Broadly speaking, these include self-evaluation, evaluation of the world of work, and the matching of these knowledges into a career choice. Arriving at the point at which one combines these knowledges, however, is a difficult process requiring a long period of time and the accumulation of a great deal of information. It requires an awareness that many occupations exist, are different, and utilize a multitude of skills and abilities" (Rosenfeld, Kowal, & Seiler, 1965). In addition, the effective forging of a career requires a strategy of information gathering and decision making which is compatible with the development of appropriate individual capabilities, the requirements and prerequisites of advanced training, and the existing and future requirements of relevant occupation areas. Certainly, the best available evidence suggests that current career selection at the high school level, for a large proportion of students, is lacking in realistic matching of individual capabilities and occupational requirements (Flanagan, Davis, Dailey, Shaycoft, Orr, Goldberg, & Neyman, 1964).

Objectives and Limitations

No single, relatively small project such as the one here described can hope to resolve all, or realistically any, of the above broad issues. However, this attempt at an initial definition of a domain of general vocational capabilities is seen as having relevance and potential contribution to the resolution of all of these fundamental issues. Indeed, the basic assumption underlying this project was that improved information about the nature of generalizable vocational skills and knowledge would be useful in resolving many of the fundamental issues of vocational education.

More specifically, objectives of this investigation may be stated as follows:

1. Development and verification of methods for deriving general capabilities from job information.
2. Description of the structure of the general vocational capabilities domain as it currently exists among high school students, and relating of this capabilities domain to intellectual aptitudes and educational experience.
3. Derivation of implications from general vocational capabilities analysis for education.

It may be noted as a specific limitation of this study, however, that it was not possible to measure manual manipulations as part of this study. It would, therefore, be inaccurate to imply that our description of the domain of general vocational capabilities is based upon direct evidence concerning this aspect of skill. However, we are inclined to agree with Fitts (Melton, 1964) that this is likely not to be a critical factor in programming for effective skill learning.

Another limitation is the sample of occupations chosen for this study. The relatively small number of occupations possible to include in this study precludes generalization to all occupations except at great risk and in a rather gross way. In particular, with the benefit of hindsight, it is probably unfortunate that our original definition of vocational education was somewhat narrow, resulting in exclusion of occupations for which a college degree is a standard requirement.

Finally, it may be that generalization is currently limited by available education. Future improvements in educational practice may well change the nature and extent of vocational capabilities generalization.

Definitions

Before we proceed further, it may be desirable to define some of the terms that will be used throughout the report and for which universal usage is lacking.

Vocational education: the totality of organized efforts on the part of a school system which are intended to be or which, in fact, are useful to students in:

- making a series of decisions relevant to a vocational choice;
- planning, preparing for, achieving, and advancing through a successful career; and
- developing and applying job-relevant capabilities.

We are talking, then, about the vocational aspects of education without reference to any special group of students or to the kinds of educational experience the individual will have after high school graduation. Thus, we are concerned with one important aspect of education, fully realizing that there are many other aspects such as preparation for responsible citizenship, the formation of personal philosophies and values, and the attainment of individual non-vocational satisfactions. We will not be bound by legal, administrative, or historic definitions of vocational education.

Job: a set of related activities in which persons regularly engage for gain. This will be used in distinction to position, which will refer to a job held by a given individual, and to occupation, which will refer to a set of related jobs. Job family and vocation will be considered to be synonymous with occupation and with each other.

Career: the set of positions, jobs, and occupations desired or held by an individual during his lifetime of employment.

General vocational capability: a set of skills and/or knowledges having relevance to a variety of occupations which go beyond the basic academic tools of reading, writing, arithmetic, and understanding general science. Following Miller and Folley (1956, p. 12), a skill "is the making of appropriate discriminations and manual manipulations. . ." Knowledges ". . .consist of the recallable information and symbol-handling that may aid in learning, performing, or generalizing discriminations and manipulations." Use of the term "capability," then, is a shorthand way of referring to both skills and knowledges.

Audience

This report is intended for two main audiences. The first audience is educational planners and practitioners. The report is offered to this audience in the hope that the study will be of some help in broadening and clarifying the reader's concept of the role education should play in preparing modern youth for a working world--certainly, the study has modified a great many of the preconceptions of the staff conducting the study.

The second audience is educational researchers. The report is offered to this audience in the hope that the study will be productive of research issues and hypotheses.

Overview

The first major section of this report is devoted to a description of the approach used in conducting the study. An initial summary of the approach may suffice for some readers. More detailed rationales and descriptions of procedures are presented on pages 9 to 31 for readers who wish to make a more detailed evaluation of study results in terms of the research operations which generated them.

The second major section of the report describes the general results from the study in terms of the structure of general vocational capabilities which was identified and the relationships of this structure to the total educational process and to intellectual aptitudes. Following the description of the general structure of general vocational capabilities are six major sections of the report, in each of which one of the principal areas of capability is described.

Following the content descriptions are two sections designed to broaden the concept of vocational capabilities. The first of these sections presents a hierarchy of psychological processes. The second introduces the notion of a processes X content grid as a framework for defining a general vocational capabilities domain.

In the final section of the report are discussed some of the major implications of the study for educational planning and practice, for further analyses of general vocational capabilities, and for future educational research.

An appendix includes samples of products from interim stages of the project and some of the detailed statistical results.

APPROACH

Summary

The approach to the study of general vocational capabilities included the following steps:

1. Selection of a set of occupations representing a variety of fields, and for which many new personnel will be needed over the next 10 to 15 years.
2. Preparation of descriptions of selected occupations and their component jobs and tasks.
3. Definition and selection of measurable performances to simulate appropriate aspects of job behavior.
4. Administration of performance measures to a sample of students.
5. Analysis of relationships among measured performances to define general capabilities.
6. Determination of relationships of general capabilities with aptitudes and with educational experience.

Selection of Occupations

Generalization of capabilities has meaning only insofar as it has reference to denotable activities. In the area of vocational education, such activities ultimately have to do with performance on the job. A logical place to start the search for generalizable capabilities, therefore, seemed to be with a definition of performance requirements for an appropriate sample of individual jobs.

The most important considerations in selecting a sample of jobs seemed to be these:

1. Inclusion of a wide variety of performance requirements. As a minimum, this meant that many different patterns of worker functions, as used in the Dictionary of Occupational Titles (D.O.T.) (U. S. Department of Labor, 1965) should be represented in the sample.
2. Inclusion of a range of performance requirement levels, at least in the sense of including some occupations commonly thought to require substantial formal training and others for which little or no specialized formal training is usually provided.
3. Emphasis on occupations for which many new personnel will be needed over the next 10 to 15 years.
4. Representation across industries, with emphasis on industries expected to absorb substantial proportions of the American labor force in the foreseeable future.
5. Inclusion only of occupations for which it would be reasonable to provide specialized vocational training at the high school level. This did not mean that only occupations for which such training was currently given were considered, but only occupations for which it was judged that specialized vocational training might be profitable were considered. (It should be noted that occupations for which a bachelor's degree or higher academic degree is required were not considered for inclusion. In retrospect, we view this decision with some regret since throughout the rest of the project we were increasingly struck by the overlap and continuity of purpose for general vocational capabilities as between college-bound and non-college-bound students.)

Discussions with Bureau of Labor Statistics personnel suggested that the single best source of information to guide selection of occupations was the Occupational Outlook Handbook (U. S. Department of Labor, 1963-1964). (The 1963-1964 edition was the latest available at the time of this phase of the project.) Accordingly, all of the occupations in the Handbook were reviewed. Only occupations judged to have significant potential vocational training implications were considered for further analysis. A preliminary selection of the 76 most promising occupations was made.

The occupations were both ranked and rated by personnel of the Bureau of Labor Statistics in terms of the number of openings likely to occur during the next decade. The rating was according to the three categories of (1) many opportunities, (2) a moderate number of opportunities, and (3) relatively few opportunities. In Table 18, page 91 of the Appendix are listed the 27 occupations that were rated as having "relatively few" opportunities. No further analysis was made of these occupations.

Thirty-one occupations were selected from the remaining 49 occupations rated as having "many" or "moderate" potential openings to represent a spread of worker functions and industries. Worker functions judged to be relevant to the selected occupations and to the others not selected are shown in Table 19 on page 92 of the Appendix. Industries in which the occupations occur are shown in Table 20 on page 93 of the Appendix.

Occupational Description

All formal efforts to derive general vocational capabilities which have come to our attention have included organization of job information as an early step. There seem to be compelling reasons for this, since derivation of general job capabilities without a good notion of what the jobs demand would lack a logical foundation. To begin with an analysis of all potential capabilities would seem to be a relatively fruitless search, since an outstanding characteristic of the human is his versatility.

Although there is uniform agreement that some type of occupational description is essential to a rigorous derivation of general vocational capabilities, there is little agreement concerning the best technique for occupational description.

For purposes of the present study, the most appropriate approach seemed to be one which proceeded from description of general characteristics of an occupation selectively through more detailed information down to the level of individual behaviors on specific tasks for delineated jobs. There are three major steps in this approach: (1) general occupational and job description, (2) task identification and enumeration, and (3) task description. Each is described below.

General Occupational Description

The general occupational descriptions were intended to place the occupation and its component jobs into an appropriate context and, more particularly, to make explicit the basis for selecting content for the more detailed analyses which followed. The general occupational and job descriptions included the following five kinds of information:

1. Definition of the population distinguished the jobs within the occupation to be considered for further analysis from those of similar title not to be further analyzed. The industries or locations in which the jobs are performed were also identified. In addition, characteristic requirements for incumbents such as examinations and certificates, nature and duration of training, sex and age, and academic achievement were described. A sample population definition for the occupation of welder is presented in Table 21 on page 94 of the Appendix.
2. The mission statement briefly summarized the objectives of the job. This statement sometimes defined alternative objectives and operational modes as well as indicating, where appropriate, hierarchies of goals. Sample mission statements for nurse, salesman, and air conditioning and refrigeration mechanic are presented in Table 22 on page 95 of the Appendix.
3. Segments identified major sub-operations of the mission and served as an important basis for organizing the arrays of

tasks that were later described. Segments were sometimes determined by the time phases or sequences which structured performance of the job. Sample segments for a waiter's job are: (a) setting tables, (b) taking orders, (c) turning in orders to kitchen or counter, (d) assembling orders, (e) serving food, and (f) preparing and tendering the bill.

4. Functions stated the major job components with which the incumbent interacts and the nature of interaction with these components. Mostly, the general worker functions established by the United States Employment Service for the Dictionary of Occupational Titles were used, but others were added where they were judged to add significantly to the description. A sample delineation of functions for practical nurse is given in Table 23 on page 96 of the Appendix.

5. Contingencies and contexts was devoted to an identification of the conditions under which the job is to be performed and the classes of unpredictable events or problems with which the worker might have to deal. Noteworthy conditions might include elements of either the physical or the organizational environment within which the job is performed. Contingencies imply some aspect of danger, emergency, special challenge, or non-routine performance. Causes of contingencies include such things as weather, accidents, illness, and malfunctions. Sample contingencies and contexts for a truck driver are presented in Table 24 on page 97 of the Appendix.

Task Enumeration

The definition of task used for task identification and enumeration on the current study, closely paraphrasing Miller's (1956) definition, was:

> A task is a group of unitary human operations having a common purpose, directed towards the same specific output(s), and usually occurring at about the same time or in close sequence.

It was assumed that tasks so defined constituted the basic building blocks for an operational description of the work performed in a given job or occupation. It should be noted that, at the task enumeration level, the emphasis was on _what_ is accomplished, _not how_.

Tasks were suggested throughout the structuring of occupations and jobs in general descriptions. This was particularly so since this structuring was based on a review of Department of Labor, union, association, industry, training, and guidance documents relating to each occupation; supplemented by observation of job operations and interviews with experts concerning the jobs.

Many of the jobs included tasks that seem not to have much potential for deriving general capabilities. Identification of such tasks before they were described in detail avoided the expenditure of large amounts of time for such description. To aid in the identification of tasks to be and not to be described in detail, the following classification of tasks was established:

1. _Basic_--tasks closely related to the central purposes of the occupation and typically performed by new incumbents and/or most journeymen. This was the only type of task described in detail.
2. _Specialty_--tasks performed by a small proportion of incumbents or only rarely performed and not closely related to the central purposes of the occupation. Specialty tasks were listed but not described.
3. _Advanced_--tasks that require considerable specialized training and/or job experience for their performance and which are only performed by the most senior workers. Advanced tasks were listed but not described, if all of the _parts_ of the task which were not "advanced" were redundant to "basic" tasks.
4. _Ancillary_--tasks for which no training beyond grammar school is required or likely to be useful. Ancillary tasks were listed but not described.

5. Redundant--tasks that are repeated during the course of performing the job in essentially the same way. Redundant tasks were described only once but variations required in repeated performance were noted.

A sample enumeration of tasks for truck driver is presented in Table 25 on page 98 of the Appendix.

Task Description

Task description for this study was considered to be the detailing of interactions among men, equipment, information, and the environment in a work context. Essentially, the approach followed methods prescribed by Miller (1956; 1962), but with the following differences:

1. Miller prescribes an explication of the initiating cues for each task. In this study, initiating cues were noted only if the analyst judged that significant trainable capabilities were involved.
2. Miller prescribes description of activities within each task along an explicit time base. No such detailing of time and sequence was required in the current study, although it was required that sequential chaining of activities be identified as sequences.
3. The criterion for adequate detail implied by Miller is that the description would permit a reader to perform the task if he had time to read or listen to the description as he performed, had the required motor skills, and knew the nomenclature and locations. The criterion set for task descriptions in the current project was that a reader could identify (that is, pick it out from similar tasks) but could not necessarily be able to perform the task from the description. This was an important difference since this latter, less stringent criterion resulted in much abbreviated statements of tasks that required considerably less expenditure of effort than would more rigorous descriptions.

Objectives for the task description included:

1. Economy of time and effort.
2. Reliability in generation and communication of task data.
3. Sufficient detail to ensure that no important skills or knowledges would be overlooked, but no excessive detail that could not be used in later phases of the project.
4. Description of job requirements in a form which was readily translatable into test measures.

Task description began with identification and naming of the task and obvious component sub-tasks. Then, information concerning the task or sub-task was recorded in the following order:

1. Object(s) acted upon. These are the object(s), person(s), and/or thing(s) which are in some way affected by the actions of the job incumbent in performing the task.
2. Information or signal(s) which guide action. These are the aspects of the task environment which trigger or guide the actions of the worker in performance of the task, including remembered information as well as external sources.
3. Tools. These are instrumentalities other than members of the job incumbent's body which he uses in carrying out his performance of the task. Ordinarily, this category was not used to denote parts of the complex of objects acted upon, but included items that could be periodically removed from the site of the task.
4. Actions. These are the processes by which the worker achieves the goals and sub-goals of the task. Ordinarily, a verb was the key aspect of the description of an action or activity but it was also usually necessary to explicitly identify the object acted upon and, sometimes, the signals guiding the action. Actions were listed approximately in

the sequence typically required in performance of the task. However, no effort was made to identify the specific body movements which were components of a given action.

5. Indications of completion of action. These are the information or signals which indicate to the worker that a task or one of its component actions is completed. These indications were generally described in terms of states of the object acted upon after the action had been successfully completed or additional information became available as a result of the action which indicated that some alternative action was required.

Sample tasks for practical nurse are presented in Table 26 on pages 99-105, for sheet metal worker in Table 27 on pages 106-108, and for programmer in Table 28 on pages 109-110 of the Appendix.

Selection of Measurable Behaviors

Given the fundamental objective of describing vocational capabilities generalizing across a number of jobs and tasks and assuming occupational descriptions which provided the data concerning operational requirements of the jobs, there remained the problem of how to convert occupational information into data that would reveal a meaningful structure of capabilities. Review of previous attacks on this problem suggested that:

1. No generally accepted or fully adequate technique existed for translating occupational descriptions into statements of general vocational capabilities.
2. It might be fruitful to conceive of the translation as a two-step process in which:

a. Job and task descriptions are reduced to sets of behavioral units at the same level of specificity.

b. Cross-comparisons are made across behavioral units to guide their re-grouping into classes of general capabilities.

Consequently, an approach was developed for this study which involved the separate identification and cross-comparison of behaviors representing the 31 occupations described in initial phases of the project. The identification and description of behaviors is described in this section. The cross-comparison and re-grouping of behaviors into statements of general capabilities is described in the next section, beginning on page 27.

Some Earlier Approaches

One might assume that key words in job descriptions imply the technologies labeled with the same word. Thus, if a job description includes the term "electronic equipment," it might be assumed that the worker should know about "electronics." The problem is, of course, that the worker may, in fact, need to know from practically nothing to a great deal about electronics. For training purposes, we need to know not only how much, but what the worker needs to know. Word matching is not an effective technique for providing either type of information. We found no serious investigations that have used word matching as an explicit technique, but it does seem to creep informally into some vocational curriculum development.

Miller and Folley (1951) have derived and defined categories of skills and knowledges for line maintenance of complex electronic equipment. They accomplished this by stating skill and knowledge categories as direct reflections of job activities, but using classes of indicators, indications, and objects acted upon rather than specific items. Thus, a given skill or knowledge category included all of the job behaviors that were (for all practical purposes) identical once specific indicators and objects were turned into classes. Sample categories are:

1. Reading calibrated dials containing continuous scales marked off in units; readings require interpolation.
2. Taking precautions or actions in specific job situations which will minimize risk of inefficient performance, of injury, or of damage to the equipment.
3. Making arithmetic computations: performing addition, subtraction, division, multiplication of whole numbers and decimals; solving single-variable linear equations.
4. Putting together electrical connections: joining male and female plugs; multi-pronged connectors; joining plugs by hand or with the assistance of tools.

Implicit in the work of a number of investigators is the assumption that there is a kind of equivalence between worker functions (Fine, 1963) and skills. This is analogous, in a sense, to the assumption (also implicit) in Miller and Folley's derivation and use of skill categories. However, the Miller and Folley skill categories are based primarily on the behaviors which make up tasks, whereas the investigators who use worker functions tend to use job activities at about the level of verbs more appropriately applied to naming tasks. The U. S. Department of Labor occupational classification structure (Fine & Heinz, 1958; U. S. Department of Labor, 1965) depends heavily on worker functions for a determination of skills. However, the functions are always associated with work fields and the material, product (also machine or equipment), subject matter, or service with which the work and technology are primarily involved. This association of different classes of information about the job is useful in considering the skills and knowledges involved in a given job but does make comparison across jobs rather unwieldy.

Schultz and Siegel (1961) report having developed Thurstone and Guttman scales for measuring (i.e., supervisory evaluation) "technical skills" in job performance. The scales are based on a task list which did not include the equipment but asked the evaluator to apply the action words on the listing to "equipment which is encompassed by the rating." The action words are ones such as removing, replacing, inspecting, instructing, etc.

Palmer and McCormick (1961) developed a job activities checklist on which a sample of 250 jobs in a steel producing firm were rated. The checklist included items such as "identifies or distinguishes sounds by pitch or tone," "evaluates performance of people," "supervises work groups," "operates typewriter," and "climbs." It can be seen that these activities represent different levels of specificity, but tend toward a rather general level of the sort that might be representative of task enumeration.

Miller (1955) has developed a preliminary theory of concept-mediation in learning and performance. This work was motivated, at least in part, by a recognition of the relatively low transfer of training predicted across similar jobs on the basis of comparing task description. Miller identified the following modes of conceptualization that tasks may possess:

1. Object imagery or map-like.
2. Abstraction and classification of objective stimuli.
3. Association of process-sequence and cause-effect.
4. Symbol or image transformation.
5. Application of self-instructions to a work situation.

Miller and Van Cott (1955) developed a rather elaborate procedure for determination of knowledge content from task descriptions, based partly on Miller's theoretical work. A key aspect of the procedure is to search through and extract statements from task descriptions that suggest concepts that would aid learning or performance of the task.

All of the approaches to definition and selection of behaviors available for review suffered one or more serious limitations for this study. Most dealt with behavior only at a level no more specific than that which would be suitable in naming tasks. It was feared that such coarse-grained analysis would miss some of the important aspects of capabilities generalization which might occur across behaviors delineated at a more specific level. Miller's approaches deal with behavior at an appropriately specific level. However, application of the Miller and Folley categories had tended to miss much of the capabilities generalization which the analysts felt probably existed even though their formal procedures failed to detect it (Miller, Folley, & Smith, 1954). The Miller and Van Cott procedure actually would have required considerable elaboration of the occupational descriptions, would have de-emphasized or eliminated non-conceptual aspects of performance, and would not have provided a ready basis for the cross-comparison of behaviors required in later stages of the study. Consequently, it became necessary to develop an approach to definition and selection of behaviors for this study.

A Way of Viewing Behavior

We have seen in our consideration of task description that the task is generally considered the smallest convenient unit into which the operations of a job can be divided, the smallest part of a job having a meaningful unitary goal or purpose. However, each task can generally be readily divided into activities or actions having a clear identity as part of the job. For purposes of this study, such activities or actions were considered to be individual, unitary behaviors. A behavior was further considered to be the smallest unit of performance having job meaning and involving clearly definable stimulus, processing, and response aspects.

The implications of each behavioral aspect for determination of skills and knowledges were judged to be as follows:

1. The stimulus aspect of a behavior includes the indicator or source of information; the indication, stimulus, or the information; and the function of receiving the indication or transforming the stimulus into nerve impulses. The indicator and indication are both important to defining the nature of skill and knowledge requirements, especially with respect to defining content. The receiving function, however, appears to be virtually irrelevent to the task of defining skill and knowledge requirements.
2. The processing aspect of behavior appears to be the primary source of differentiation among behaviors with respect to the form of skills and knowledges involved. Various processes

are defined and their implications for deriving skill and knowledge tests are summarized in Table 29 on page 111 of the Appendix. Psychological processes may be considered to be characteristic modes by which stimuli are translated into responses.

3. The response aspect of behavior includes both the object acted upon and the nature of the response. It is essential to adequate skill and knowledge derivation to identify the varieties of objects upon which the worker acts. It is also of interest to identify the nature of the actions or overt responses made by the worker, although many or most of these may be well within almost any adult repertory and would be trivial to measure in their own right. Various response categories and their implications for skill and knowledge tests are summarized in Table 30 on page 112 of the Appendix.

The approach to skill and knowledge identification in the present study was to translate task descriptions into test measures which reflected behaviors required on the job. Preliminary experience suggested that general occupational information presented prior to the detailed task descriptions was used to support the substantive content of items resulting from behaviors implied in the task descriptions. Consequently, the detailed search for a representative sample of measurable behaviors for each occupation was based directly on task descriptions only, on the assumption that adequate representation would be made of the relevant occupational information as it was drawn upon to generate test items for the behaviors implied in the task descriptions. Thus, the problem of skill and knowledge derivation became one of:

1. Randomly selecting actions from the task descriptions.
2. Deriving measurable behaviors from the selected actions.
3. Describing and analyzing the measurable behaviors.
4. Translating behaviors into test items.

Selection of Actions

The actions were essentially the individual line items listed under the "Action" section of the task descriptions. Actions which were redundant were not included in the population. This meant that if a subsequent task included the same sequence of actions as already included in the population, these repetitious actions were deleted from the population. Only unique actions for the semi-redundant task were included. For some of the more complex, non-procedural tasks such as patrolling a beat for the policeman, this required some special analysis to determine the classes of specific actions included under a summary action statement.

Where sequence was essential for correct performance of a task and following the sequence required more than an ability to read or follow verbal instructions, an action of "sequence following" was included in the population.

Selection of a representative sample of actions for a given job simply required random choice of actions which were to be translated into statements of measurable behavior.

Deriving Measurable Behaviors

Actions which met the following criteria were translated directly into measurable behaviors:

1. Represented the most important, psychologically meaningful, and error-prone components of the action.
2. Was small enough to be encompassed in a single test item (although it must be recognized that other non-overlapping items might be prepared for the same behavior), but was not trivial or unimportant in performance of the job.
3. Could not be done reliably and automatically by a complete novice.
4. Represented the kind of specific instruction a competent tutor might give a novice in one or two guided performances of the task.

Description of actions in the task analyses were sometimes inadequate for a direct translation into statements of measurable behaviors. It was sometimes necessary to further analyze actions in the job descriptions to reveal appropriate measurable behaviors. For example, the action for a power-shovel operator might be to pull a particular lever to swing the shovel to the right. Reaching out and grasping the lever is trivial from a skill point of view. Selection of the proper lever might be specific to different makes and models of shovels and might also be made trivial by appropriate labeling. However, the fact that one must anticipate inertia in order to stop the shovel at the proper point rather than overshooting may make for a very good measurable behavior. Thus, the statement of measurable behavior for this action might be, "Stops swing of shovel without overshoot." The actual psychomotor performance of swinging the shovel could not be measured, but the knowledge of the need to anticipate overswing could be.

Because not all actions lent themselves to translation into measurable behaviors, the random selection of actions was continued until 40 measurable behaviors were described. Reasons for not deriving a measurable behavior from an action were:

1. The action, in all of its aspects, was clearly already in the repertory of almost all grammar school graduates; or of 18-year olds, whether or not they attended high school.
2. The action could be acquired almost immediately on the job without specialized training or guided practice.
3. In all of its significant aspects, the action was obviously specialized and specific to a given job context, especially highly skilled psychomotor activity.

Describing and Analyzing Measurable Behaviors

Analysis of behaviors in terms of their measurable characteristics had three major purposes:

1. To eliminate from further consideration those job operations and behavioral aspects which were either undesirable or unfeasible to test.
2. To identify and delineate those behavioral aspects and characteristics which were suitable for testing.
3. To arrange and codify measurable aspects of behavior in such a way that sampling for the development of measures would be facilitated.

A preliminary form for reporting the results of task analysis to identify measurable behaviors is shown as Table 31 on page 113 of the Appendix.

All of the relevant psychological processes and responses that were feasible to test could be indicated. However, only those functions which were desirable to measure were indicated. Thus, only those behavioral aspects which were serious contenders for the testing part of the project were included in the analysis. It was assumed that multiple functions for a given performance statement meant that they should all be measured as part of the same item. Separate statements of performance were made for each new potential item, even if the separate statements were drawn from the same task step.

Translating Behaviors into Items

Some years ago, Flanagan (1951) reported on progress being made by the American Institute for Research on the development of a method for logically bridging test items to job behaviors, a method called rationales. The primary steps involved in this method are summarized below, along with their parallels on the current project:

1. Identifying and listing behaviors to be sampled or predicted. This step sets both the objectives and limits for the tests. In the current project, identification and listing of behaviors was accomplished by means of job and task description

rather than by use of the critical incident technique with which the method of rationales is more commonly associated.

2. Description of the behavior. This step "involves the definition, delimitation, and illustration of the variety and scope of the actions included." The most analogous step on the current project was the listing of measurable performances. These individual performances were very specific and required, therefore, minimal elaboration.

3. Analysis of the behavior. This step involves classifying the behavior and relating it to other behaviors as well as making inferences about its nature. An analogous step was accomplished as part of the current project in determining the psychological processing and response characteristics which it was desired to measure since such characteristics are presumably a reasonable basis for classifying and relating behaviors to each other.

4. Formulation of item specification. This step involves describing the item which will presumably validly estimate the specified behavior and includes both deductions about the nature of the relationship between behavior and item and practical suggestions. For the following reasons, it seemed unnecessary to include formal item specification as part of the current project:

    a. The current items were sample elements of the job performance. Consequently, the content of a given item was obvious from the statement of the performance and the job-task context in which it occurs.

    b. The form of items was rather specifically determined by the processing and response characteristics which the analysis has specified as being desirable to measure.

c. All of the original job and task context was available and coded to the item at any stage of development for the writer or editor to review to ensure that there was, in fact, a logical bridge between item and the relevant job performance.

All test items were five-alternative, multiple-choice questions. Each of the 31 occupations was represented by 19 or 20 questions. (There was approximately a 50 per cent attrition rate in translating selected behaviors into suitable items.) The entire battery consisted of 600 items assigned randomly to four test booklets of 150 items. Sample items are shown in Table 32 on page 114 of the Appendix.

Analysis of Performance Data

Culmination of efforts to define general vocational capabilities is reached in making comparisons across behaviors to estimate the nature and extent of transfer. Thus, if ability to perform one behavior is always accompanied by the capability to perform another, it is an indication that there is generalization or transfer between the behaviors. However, if a given behavior is not associated with increased capability to perform another, there is no evidence of transfer or generalization between them.

A number of approaches have been made to the comparison of behaviors as a basis for describing generalization of occupationally relevant capabilities. Some of these are summarized to provide perspective for the approach followed in the current study.

Some Available Techniques

Fine (1957) has been concerned with ways of organizing occupational information in order to facilitate judgments about the feasibility and practicality of transfer from one job to another, which is presumably largely determined by skill generalization. Table 3 shows the orders of similarity which have been defined by Fine.

Table 3

Fine's Orders of Similarity

Order of Similarity	Worker Functions	Work Fields	Materials, Products, Subject Matter, and Services
First	Same	Same	Same
Second	Same	Same	Different but related
Third	Same	Same	Different and unrelated
Fourth	Same	Different but related	Same or related
Fifth	Same	Different but unrelated	Different and unrelated

Many vocational curriculum studies and developments have been based on grouping and categorizing of jobs. The most recent Dictionary of Occupational Titles (U. S. Department of Labor, 1965) describes trait groups within areas of work. These traits appear to be highly abstracted statements of the activities required of the worker. Although organizations and groupings of occupational information such as these have a high degree of common sense appeal, they have, on closer analysis, severe limitations. If jobs are grouped according to some criteria external to general capabilities, there is no particular reason to assume that the resulting groups will have relevance to worker capabilities. If it is left to the recipient of organized, abstracted, and grouped occupational information to draw inferences concerning generalization of capabilities, the definition of a general vocational capabilities domain is dependent upon the individual, and usually implicit, expertise of the occupational data user. If assumptions are made concerning the basic capabilities which serve to define similarity among occupations, the main issue, which was to define these basic capabilities in the first place, has been avoided in favor of a priori beliefs.

Miller and Folley (1951) first developed categories of skills and knowledges for line maintenance of the Q-24 bombing navigational system. These same categories were then used in comparing the job requirements of the Q-24 with the K-1 bombing navigational system (Miller, Folley, & Smith, 1954), and later both of these systems with the A-3A fire control system. The comparison in all cases was an identification of behaviors that were the same or verbal descriptions of the way in which the behaviors differed from one system to the other. One conclusion was that "a greater amount of transfer would be realized over the maintenance of the three equipments than can be accounted for through comparisons of specific job behaviors" (Folley & Miller, 1955, p. 19).

In their development of core training for F-86D fighter aircraft electronic maintenance positions, Miller and Folley (1956) abandoned the comparison across jobs within skill categories and instead made direct comparisons of task descriptions and conceptual analyses. Peterson, Jones, and Ellis (1957) in their development of core training for electronic maintenance of the F-102 fighter aircraft, also used direct comparison of tasks to determine common skills. Analysis of task descriptions was supplemented by analysis of:

1. job objects,
2. job instructions (particularly for assumptions about what the man knows),
3. precautions, and
4. job tricks.

in lieu of the more elaborate analyses of conceptual content prescribed by Miller and Van Cott (1955) and applied to the F-86.

In a study to develop recommendations for a core system of Navy radar operator training devices; Peterson, Lewandowski, and Daily (1960) made comparisons across tasks to identify identical task elements in different jobs. Presumably, skill generalization would be complete across identical task elements.

Palmer and McCormick (1961) performed a factor analysis of job activities found in 250 jobs in a large steel company, from which they identified 14 group and four general factors. The implications of this "probing" project are not clear except for encouraging further research. Orr (1960) reported a clustering of jobs from the D.O.T. on the basis of similar aptitude profiles. Thorndike, Hagen, Orr, and Rosner (1957) have similarly studied Air Force jobs.

Schill and Arnold (1965) extracted skill and knowledge statements from technical institute catalogs. Technicians and technician supervisors from six different technologies then rated (Q-sort technique) the statements for relatedness to their technology. Each statement for which there was almost complete agreement across technologies that it was related or unrelated were identified and removed from further analysis. Relationships among ratings for remaining statements were then factor analyzed.

All of the approaches reviewed under the current study seemed to be dependent upon one or more of the following types of judgment:

1. Judgment of the analyst of the nature of generalization.
2. Judgment of the analyst of relevance of human capabilities to different jobs.
3. Judgment of job incumbents (or their supervisors) of the relevance of classes of knowledge to jobs.

For purposes of the present study, a more direct and potentially fruitful approach seemed to be one which emphasized comparison of measured performance on simulated job behaviors (test items).

Performance Analysis for the Current Study

Tests for the 31 occupations analyzed as part of this study were administered to about 10,000 students from ninth grade through junior college in Woods County (Parkersburg), West Virginia and Quincy, Massachusetts school systems.

Items for each occupation were rationally organized into a set of tests, resulting in a total of 99 tests. Scores for these tests were intercorrelated and factor analyzed by the principal components method and rotated using a normal varimax criterion. Analyses were performed for girls and boys separately and for the combined group. Raw correlation, unrotated factor, and rotated factor results were reviewed in detail in the light of estimates of reliability for the tests and rational expectations. No meaningful structure or insights occurred.

Scores for each test and all tests for each occupation were analyzed in terms of relative male versus female mean performance. Results for all 31 occupations and 99 original tests are presented in Table 33 on page 115 of the Appendix. The ordering of occupations and tests on the basis of mean sex differences seemed to make a great deal of sense in terms of an underlying continuum of something like hardware to people. Items were assigned to 24 tests in six major areas based on the assumption of such an underlying continuum.

These new tests were intercorrelated, revealing a correlational pattern which is roughly compatible with an underlying molar structure of open contiguity (Jones, 1960). Deviations from a pattern of correlations proportional to distances along the male-female superiority continuum were examined to identify special relationships within the more general pattern.

Comparisons between twelfth graders and the composite* of students from other grades was used to infer the nature of development and change of general vocational capabilities as they are reflected by the 24 tests and six areas.

Verbal and numerical aptitude scores were obtained on the SRA Verbal test. The amount of training, average grade, and liking of students for a number of course areas were obtained from each student. These reference data were correlated with vocational capabilities test scores for twelfth graders.

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* About six per cent of the composite were junior college students. This relatively small proportion should not greatly affect composite results.

GENERAL RESULTS

Basic Vocational Capabilities in the Educational Process

Before we can proceed meaningfully with a description of structure within the general vocational capabilities domain, it is desirable to delineate where this domain fits into the larger educational process. Figure 1 represents an attempt to suggest where, in a total educational experience, there might be a focus on the development of general vocational capabilities. Even such a simple and schematic model as this, however, suggests that there are a number of prerequisite, coordinate, and subsequent aspects to an educational experience which, although related to general vocational capabilities, can readily be separated from them.

If we accept this view of where general vocational capabilities might fit into an educational experience, it is possible to derive several characteristics for them; they:

1. Follow and assume the prior acquisition of the basic intellectual tools such as systematic problem solving, scientific method, written and oral communication, and arithmetic.
2. Gain from knowledge which supports the development of basic concepts concerning the relationships of society and work, from the assimilation of occupational and self-knowledge into career planning, and from the development of effective work attitudes and habits.
3. Are capable of parallel and harmonious development along with achievement of broader educational goals such as inculcation of our cultural heritage, enhancement of self-actualization and fulfillment capabilities, and development of citizenship capabilities.

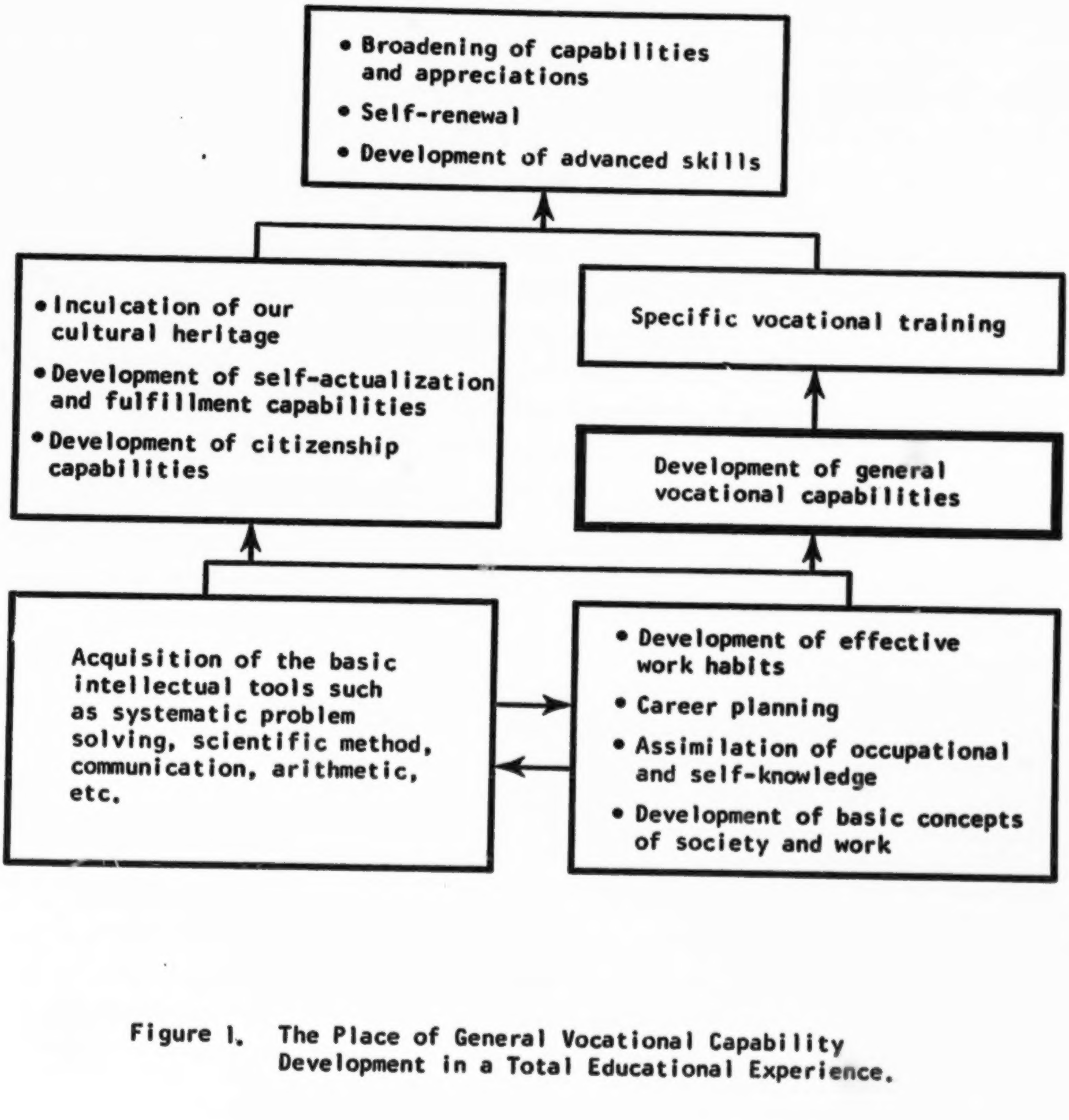
• Broadening of capabilities and appreciations
• Self-renewal
• Development of advanced skills
• Inculcation of our cultural heritage
• Development of self-actualization and fulfillment capabilities
• Development of citizenship capabilities
Specific vocational training
Development of general vocational capabilities
Acquisition of the basic intellectual tools such as systematic problem solving, scientific method, communication, arithmetic, etc.
• Development of effective work habits
• Career planning
• Assimilation of occupational and self-knowledge
• Development of basic concepts of society and work

Figure 1. The Place of General Vocational Capability Development in a Total Educational Experience.

4. Can contribute importantly to the learning of specific vocational content and skills.

5. Have long-range implications for lifelong goals such as achieving breadth of understanding, self-renewal and up-dating, and development of advanced skills beyond those required for employability or entry levels of occupational performance.

Within such a framework, then, how can we most effectively learn more about the nature of general vocational capabilities?

The Structure of General Vocational Capabilities

Sex Differences

An early clue to a potentially useful structure for the general vocational capabilities domain resulted from analysis of mean performance differences between the sexes. In Figure 2 are shown results for total scores on each occupation. (More detailed results for sub-tests within each occupation are shown in Table 33 on page 115 of the Appendix.) It can be seen that performance, as measured by job simulation tests developed in this study, involved large sex differences. In evaluating these results, they seemed to suggest that underlying the sex differences was a continuum from hardware to people, with data handling, symbolic manipulations, and communication being toward the middle.

On the basis of an assumed hardware-symbolic-people continuum, items were rationally organized into six major areas and 24 sub-tests. Mean sex differences for these sub-tests are shown for seniors in Figure 3 on page 37 and for a composite of ninth grade through junior college in Figure 4 on page 38. (More detailed data concerning mean sex differences in performance are shown in Table 34 on page 116 of the Appendix for seniors and in Table 35 on page 117 of the Appendix for all grades.)

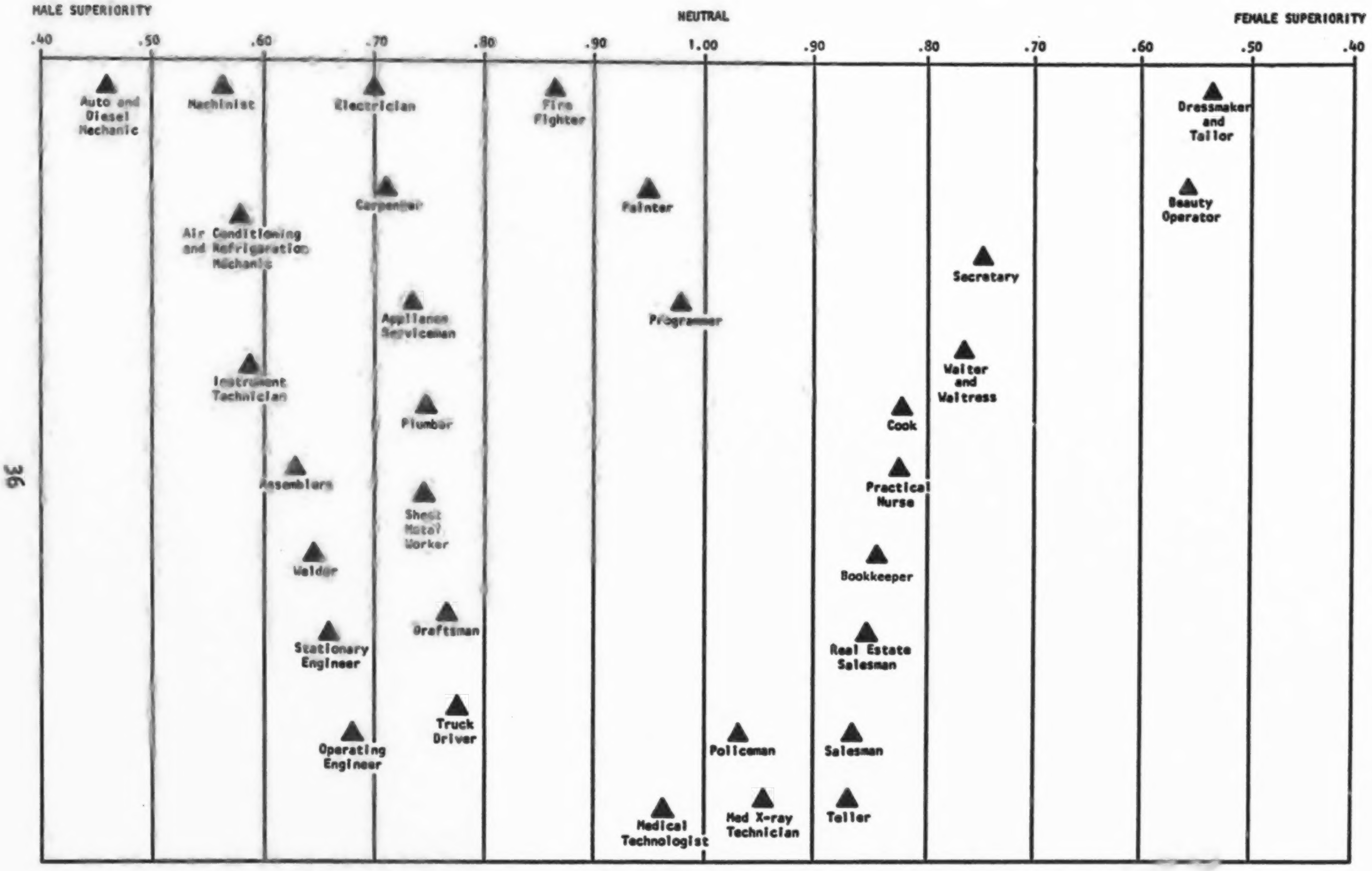

Figure 2. Male Versus Female Superiority for the 31 Occupations Tested--All Grades Combined (Example: .40 on the "Male Superiority" end of the scale would indicate that females did four-tenths as well as males.)

(Example: 90 on the "Female Superiority" end would indicate males did nine-tenths as well as females)

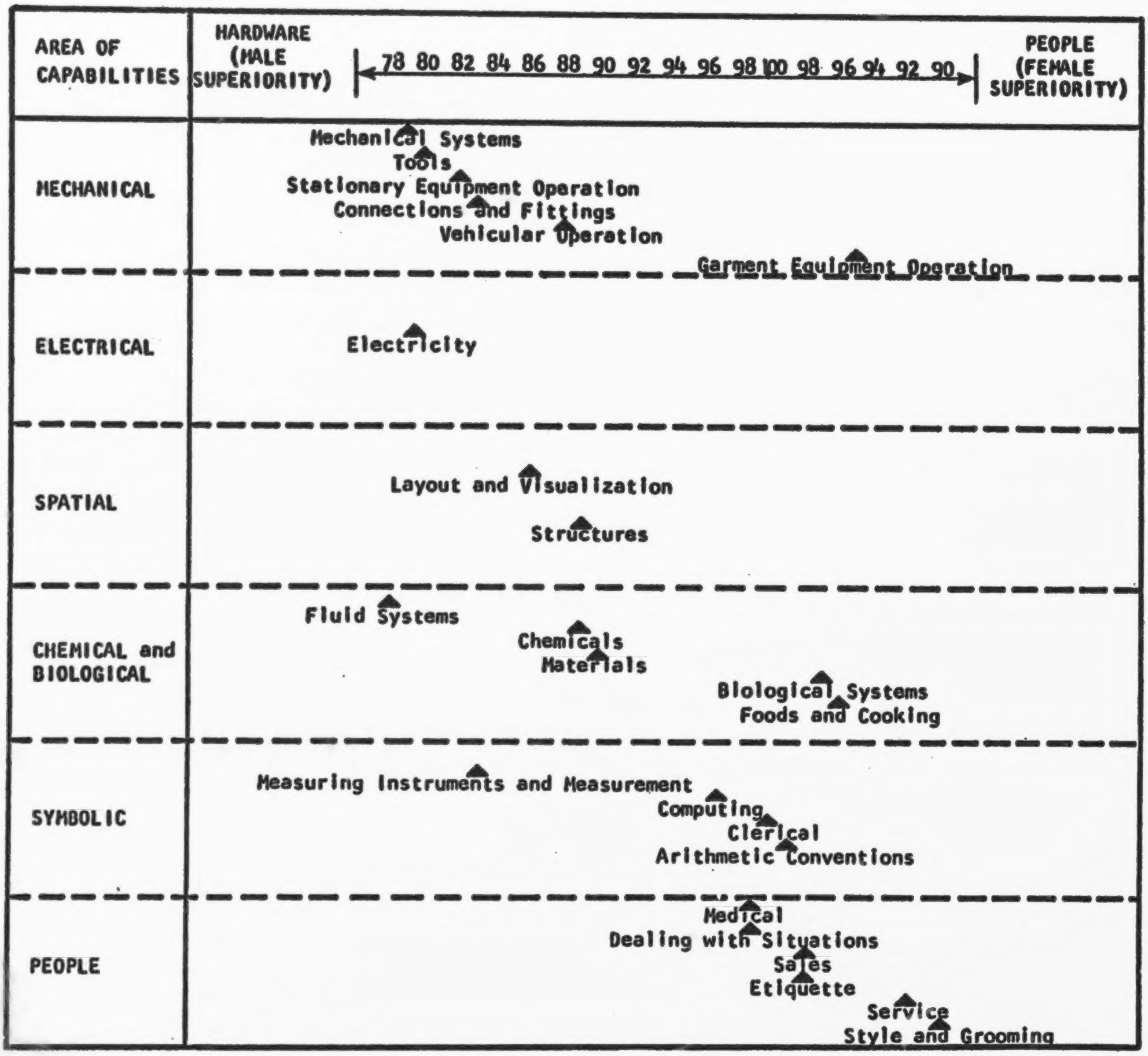

Figure 3. A Pattern of General Vocational Capabilities for 12th Grade Students (based on 757 males and 681 females).

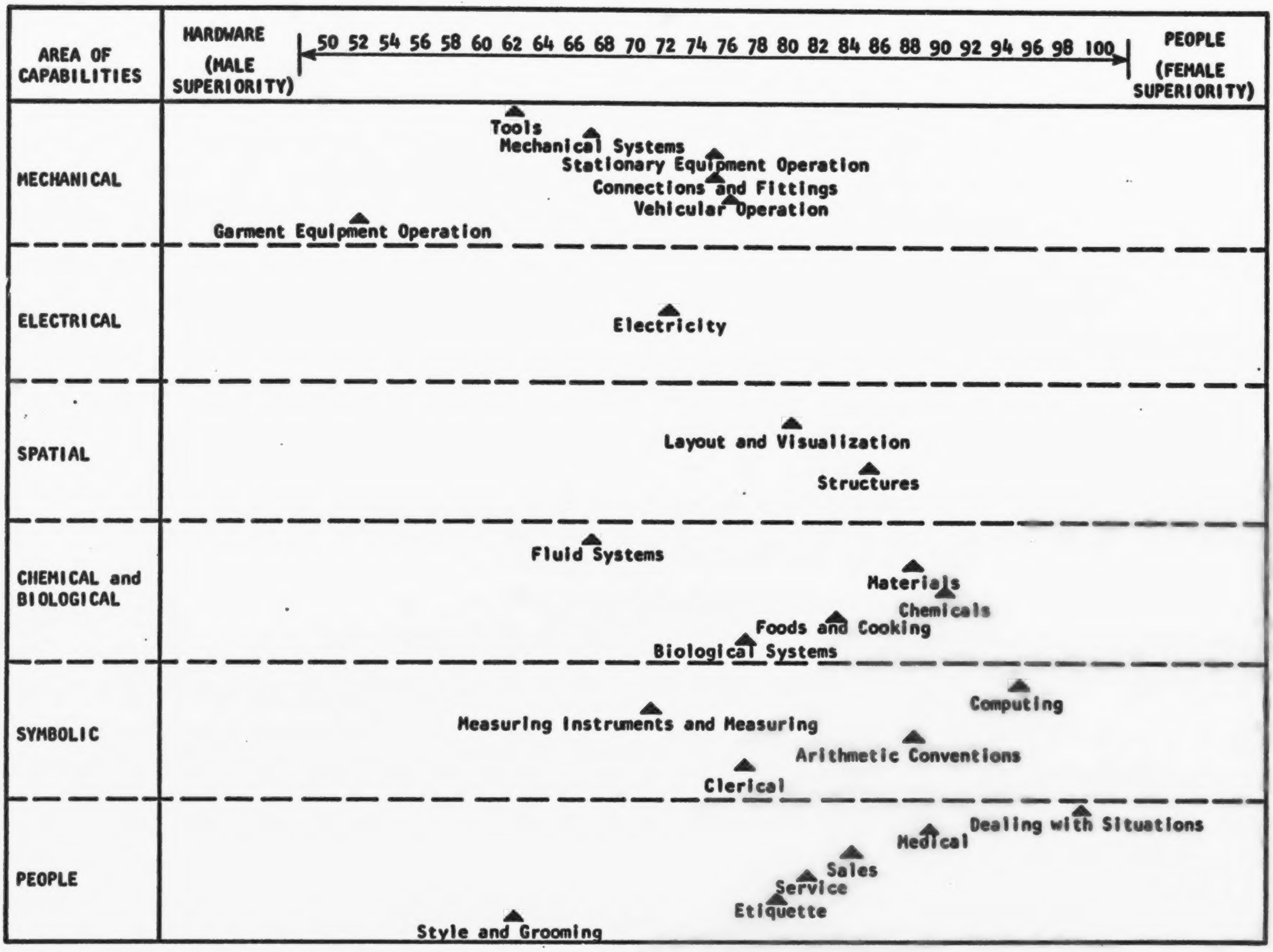

Figure 4. A Pattern of General Vocational Capabilities for a Composite of 9th Grade through Junior College Students (based on 2662 males and 2610 females)

Comparison of sex differences for all grades versus seniors only reveals that the magnitude of sex differences becomes less with age. However, the ordering of tests according to sex differences tends to remain rather constant.

Correlational Patterns

If an underlying dimension of hardware-people does importantly influence the structure of general vocational capabilities, we would expect capability areas close together on the hardware-symbolic-people continuum to be highly correlated and those areas far from each other to have low correlations. In Table 4 on page 40 are shown correlations among the six areas for seniors, and in Table 5 on page 41 for students from ninth grade through junior college.

Table 4 reveals that, for seniors, there is, indeed a very strong tendency for capability areas close on the hardware-symbolic-people continuum to be highly correlated (correlations close to the diagonal black boxes) and those areas far from each other (correlations far from the diagonal) to have low correlations.* For human behavioral data, this reveals an exceptionally orderly and well-structured domain for basic vocational capabilities, for this population and as measured by these particular tests.

In contrast to results for seniors only, we may note two important differences for results from all grades combined, as revealed in Table 5. First, the correlations for combined groups tend to be higher. Second, the patterning of correlations--high at the diagonal and low away from the diagonal--is less clear. Taken together, these differences suggest that age- and/or grade-related factors are tending to inflate the correlations and obscure their utility as reflections of the capability domain. Consequently, emphases in the more detailed analyses have been placed on results for seniors only, although a matrix of correlations for all grades is presented in Table 36 on page 118 of the Appendix for comparison purposes.

The initial approximation to ordering individual tests was by degree of mean sex difference in performance. The patterns of obtained correlations

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* Inclusion of garment equipment operation under the mechanical area on a priori grounds tended to obscure the pattern since garment equipment operation was found to be markedly non-homogeneous with the other mechanical tests.

Table 4

Intercorrelations of Major Areas of General Vocational Capabilities for 12th Grade Students

(results for 757 males shown above the diagonal and for 681 females below the diagonal)

								MALE		
		1	2	3	4	5	6	MEANS	STD. DEV.	RELIA.*
1.	MECHANICAL		.796	.733	.671	.558	.275	66.54	20.06	.912
2.	ELECTRICAL	.801		.688	.647	.579	.297	13.90	5.57	.791
3.	SPATIAL	.745	.694		.661	.685	.430	18.26	5.95	.760
4.	CHEMICAL and BIOLOGICAL	.622	.582	.616		.704	.674	33.29	8.91	.809
5.	SYMBOLIC	.506	.508	.638	.688		.705	51.86	14.18	.888
6.	PEOPLE	.167	.179	.352	.633	.676		63.01	15.99	.898
FEMALE	MEANS	55.56	11.01	15.98	31.34	49.60	65.02			
	STD. DEV.	19.26	5.27	6.11	8.36	13.99	16.01			
	RELIA.*	.898	.789	.788	.789	.881	.890			

* split half

Table 5

Intercorrelations of Major Areas of General Vocational Capabilities for Students from 9th Grade through Junior College

(results for 2662 males shown above the diagonal and for 2610 females below the diagonal)

		1	2	3	4	5	6	MALE		
								MEANS	STD. DEV.	RELIA.*
1.	MECHANICAL		.785	.742	.770	.683	.625	67.97	19.90	.919
2.	ELECTRICAL	.724		.697	.735	.685	.609	13.91	5.57	.809
3.	SPATIAL	.686	.606		.711	.725	.652	17.93	5.97	.768
4.	CHEMICAL and BIOLOGICAL	.720	.592	.652		.778	.785	31.03	9.79	.841
5.	SYMBOLIC	.621	.517	.665	.698		.817	47.19	15.18	.899
6.	PEOPLE	.501	.380	.547	.713	.769		54.93	15.51	.888
FEMALE	MEANS	49.88	9.99	14.84	30.67	46.26	66.74			
	STD. DEV.	14.54	4.28	5.17	8.27	14.26	15.91			
	RELIA.*	.848	.690	.689	.781	.884	.886			

* split half

(Table 37 on page 119 of the Appendix), correlations corrected for unreliability (Table 38 on page 120 of the Appendix), and deviations from degrees of relationship which would be proportional to mean sex differences (Table 39 on page 121 of the Appendix) were examined. Two of the tests seemed not to fit well into the domain of general vocational capabilities as defined by the other tests. "Computing" did not show a very consistent trend of relationship along the continuum as defined by sex differences. Review of the content for this test suggested that, despite job context for its various items, it was probably essentially measuring only basic arithmetic ability. Thus, "Computing" seems to be even more basic than the other capability tests and fails to parallel their pattern of generalization.

In contrast to "Computing," "Operation of Garment Equipment" seemed somewhat more specific than the other capability tests. Although it correlated high with a few tests such as "Style and Grooming," "Operation of Garment Equipment" correlated less highly with most of the other tests than would be expected on the basis of its relative male-versus-female performance superiority. Indeed, its position as a test having somewhat superior female performance belies its essentially mechanical operational content. Even for males, it was decidedly not positively related to other mechanical behaviors. All in all, it seemed best not to struggle too hard to force "Operation of Garment Equipment" to be parallel with other general vocational capabilities.

Once "Computing" and "Operation of Garment Equipment" were set aside, it became possible to re-arrange tests rather strictly along a hardware-symbol-people continuum without overlap between major areas. This involved moving "Measuring Instruments" from the "Symbolic" and "Fluid Systems" from the "Chemical-Biological" area to the "Mechanical" area. It also involved moving "Medical and First Aid" from the "People" area to the "Chemical-Biological" area.

The pattern of obtained correlations for tests re-ordered along these lines is shown in Table 6 on page 43. The pattern of proportions of variance in common between tests, corrected for unreliability, is presented in Table 7 on page 44. Neither of these tables presents an accurate reflection of

Table 6

Obtained Correlations between Tests, Ordered by a Hardware-People Continuum

(results for 757 male seniors above the diagonal and for 681 female seniors below the diagonal)

KEY:

1 Mechanical
2 Electrical
3 Spatial
4 Chemical-Biological
5 Symbolic
6 People

		1							2	3		4					5		6					Male		
		Tools	Mechanical Systems	Measuring Instruments	Stationary Equipment Operation	Vehicular Operation	Connections and Fittings	Fluid Systems	Electricity	Layout and Visualization	Structures	Materials	Chemicals	Foods and Cooking	Biological Systems	Medical and First Aid	Arithmetic Conventions	Clerical	Sales	Dealing with Situations	Service	Etiquette	Style and Grooming	Means	Standard Deviations	Split Half Reliabilities
1	Tools		.815	.744	.548	.679	.683	.629	.727	.565	.568	.577	.494	.100	.010	.210	.156	.050	.082	.358	.006	.006	-.216	22.57	8.35	.853
	Mechanical Systems	.786		.732	.548	.683	.668	.644	.750	.584	.601	.590	.551	.132	.077	.273	.229	.015	.143	.385	.047	.032	-.162	13.82	5.20	.732
	Measuring Instruments	.742	.725		.418	.665	.642	.547	.700	.672	.591	.622	.512	.166	.095	.351	.267	.122	.202	.427	.156	.149	-.149	13.61	4.48	.733
	Stationary Equipment Operation	.576	.613	.476		.457	.532	.509	.500	.355	.400	.384	.412	.115	.078	.181	.177	.021	.100	.244	.043	.002	.015	2.89	1.68	.417
	Vehicular Operation	.665	.698	.672	.461		.636	.544	.617	.588	.601	.559	.488	.210	.125	.370	.317	.161	.244	.474	.190	.163	-.027	13.06	3.88	.605
	Connections and Fittings	.712	.690	.630	.564	.615		.588	.682	.583	.588	.575	.510	.175	.116	.310	.269	.125	.194	.353	.143	.114	-.043	7.90	3.42	.654
	Fluid Systems	.598	.619	.547	.487	.488	.567		.590	.424	.488	.504	.501	.176	.094	.291	.238	.071	.178	.353	.073	.091	-.043	3.09	1.71	.489
2	Electricity	.705	.753	.693	.548	.655	.707	.559		.605	.630	.631	.604	.218	.167	.375	.351	.159	.270	.402	.170	.134	-.087	13.90	5.57	.791
3	Layout and Visualization	.592	.618	.672	.420	.586	.584	.428	.640		.602	.618	.498	.254	.199	.427	.398	.245	.342	.429	.272	.285	.008	9.02	3.66	.690
	Structures	.561	.579	.609	.412	.571	.575	.422	.613	.632		.583	.516	.249	.209	.397	.376	.228	.347	.393	.224	.208	.035	8.45	2.87	.569
4	Materials	.560	.592	.609	.435	.560	.520	.475	.592	.577	.564		.607	.404	.278	.539	.423	.311	.449	.504	.362	.323	.148	9.04	3.24	.579
	Chemicals	.482	.529	.548	.485	.476	.533	.469	.593	.506	.467	.569		.354	.294	.511	.443	.318	.406	.375	.279	.282	.159	7.81	2.87	.570
	Foods and Cooking	-.014	.058	.101	.054	.106	.094	.082	.107	.164	.207	.328	.290		.426	.539	.426	.479	.486	.407	.464	.437	.463	8.78	2.62	.458
	Biological Systems	-.023	.051	.089	.012	.065	.033	.022	.085	.174	.189	.239	.226	.412		.472	.422	.413	.442	.197	.364	.336	.430	3.45	1.45	.256
	Medical and First Aid	.195	.250	.315	.219	.285	.237	.227	.307	.389	.394	.500	.454	.519	.477		.608	.547	.627	.516	.557	.488	.445	14.43	4.76	.708
5	Arithmetic Conventions	.041	.134	.185	.119	.249	.153	.112	.234	.276	.321	.347	.328	.464	.335	.488		.616	.693	.451	.528	.428	.396	16.75	5.40	.655
	Clerical	-.104	-.048	.040	.014	.078	.000	-.020	.047	.170	.193	.236	.218	.516	.375	.501	.611		.627	.356	.532	.434	.489	7.50	3.00	.575
6	Sales	-.005	.066	.158	.037	.203	.071	.066	.165	.244	.281	.375	.318	.541	.403	.573	.662	.636		.474	.590	.515	.432	15.67	5.06	.728
	Dealing with Situations	.195	.207	.295	.121	.343	.208	.152	.246	.303	.378	.380	.327	.423	.286	.468	.405	.397	.511		.405	.418	.188	9.94	2.98	.499
	Service	-.090	.015	.059	.036	.139	.011	.004	.082	.196	.185	.279	.249	.539	.408	.542	.537	.588	.631	.449		.470	.444	7.87	2.48	.434
	Etiquette	-.057	-.042	.043	-.002	.063	.018	-.088	.013	.142	.186	.227	.163	.439	.280	.382	.409	.450	.497	.427	.476		.415	4.25	1.70	.442
	Style and Grooming	-.282	-.171	-.153	-.052	-.107	-.112	-.116	-.101	.023	.067	.093	.131	.511	.460	.438	.436	.560	.507	.324	.542	.432		9.55	3.75	.670
Female	Means	18.24	10.96	11.62	2.38	11.52	6.58	2.40	11.02	7.79	7.51	8.13	7.02	9.18	3.64	14.27	16.92	7.52	16.02	9.86	8.59	4.36	10.64			
	Standard Deviations	7.66	5.19	4.52	1.58	4.08	3.14	1.59	5.28	3.77	2.81	3.08	2.63	2.88	1.47	4.47	5.53	3.08	5.08	2.94	2.68	1.61	3.74			
	Split Half Reliabilities	.825	.775	.754	.405	.643	.570	.435	.789	.732	.583	.574	.486	.540	.151	.658	.632	.607	.758	.485	.524	.217	.643			

Table 7

Proportions of Variance in Common (r^2) between Tests (Corrected for Attenuation) Ordered by a Hardware-People Continuum

(results for 757 male seniors above the diagonal and for 681 female seniors below the diagonal)

KEY:

1 Mechanical
2 Electrical
3 Spatial
4 Chemical-Biological
5 Symbolic
6 People

		1							2	3		4					5		6					Male		
		Tools	Mechanical Systems	Measuring Instruments	Stationary Equipment Operation	Vehicular Operation	Connections and Fittings	Fluid Systems	Electricity	Layout and Visualization	Structures	Materials	Chemicals	Foods and Cooking	Biological Systems	Medical and First Aid	Arithmetic Conventions	Clerical	Sales	Dealing with Situations	Service	Etiquette	Style and Grooming	Means	Standard Deviations	Split Half Reliabilities
1	Tools		1.000	.886	.843	.893	.835	.950	.784	.542	.666	.674	.502	.026	.000	.073	.043	-.004	.011	.300	.000	.000	-.082	22.57	8.35	.853
	Mechanical Systems	.967		.998	.984	1.000	.931	1.000	.971	.675	.866	.821	.729	.051	.032	.145	.109	.000	.038	.405	.006	.003	-.053	13.82	5.20	.732
	Measuring Instruments	.886	.901		.572	.998	.860	.866	.845	.893	.837	.913	.627	.083	.048	.237	.148	.036	.077	.497	.075	.068	-.045	13.61	4.48	.733
	Stationary Equipment Operation	.994	1.000	.744		.829	1.000	1.000	.758	.438	.675	.610	.714	.068	.056	.112	.114	.000	.033	.288	.011	.000	.000	2.89	1.68	.417
	Vehicular Operation	.834	.978	.934	.819		1.000	1.000	.795	.830	1.000	.891	.690	.159	.103	.320	.253	.075	.136	.745	.137	.101	-.002	13.06	3.88	.605
	Connections and Fittings	1.000	1.000	.923	1.000	1.000		1.000	.899	.754	.930	.873	.697	.103	.078	.207	.168	.043	.080	.383	.070	.045	-.005	7.90	3.42	.654
	Fluid Systems	.997	1.000	.912	1.000	.853	1.000		.899	.534	.856	.898	.900	.138	.072	.246	.178	.018	.090	.512	.024	.037	-.006	3.09	1.71	.489
2	Electricity	.763	.928	.807	.938	.846	1.000	.910		.670	.882	.869	.809	.133	.139	.252	.237	.055	.127	.410	.085	.051	-.015	13.90	5.57	.791
3	Layout and Visualization	.579	.674	.819	.595	.730	.818	.575	.709		.921	.955	.631	.206	.226	.372	.350	.151	.233	.535	.247	.266	.000	9.02	3.66	.690
	Structures	.655	.741	.843	.720	.872	.997	.701	.817	.934		1.000	.821	.238	.301	.392	.378	.159	.290	.542	.202	.171	.003	8.45	2.87	.569
4	Materials	.662	.787	.857	.815	.851	.826	.904	.773	.793	.949		1.000	.615	.520	.710	.472	.291	.479	.879	.522	.406	.057	9.04	3.24	.579
	Chemicals	.579	.743	.820	1.000	.728	1.000	1.000	.919	.719	.770	1.000		.479	.589	.646	.525	.308	.398	.496	.316	.317	.065	7.81	2.87	.570
	Foods and Cooking	-.000	.007	.025	.014	.032	.029	.030	.026	.068	.137	.348	.321		1.000	.898	.763	.844	.709	.725	1.000	.946	.697	8.78	2.62	.458
	Biological Systems	-.008	.026	.070	.000	.041	.012	.000	.059	.270	.409	.655	.699	1.000		1.000	1.000	1.000	1.000	.305	1.000	1.000	1.000	3.45	1.45	.256
	Medical and First Aid	.070	.124	.200	.180	.192	.149	.182	.181	.313	.404	.661	.644	.758	1.000		.797	.735	.763	.754	1.000	.760	.418	14.43	4.76	.708
5	Arithmetic Conventions	.004	.037	.071	.055	.153	.064	.047	.110	.164	.280	.331	.352	.630	1.000	.572		1.000	1.000	.621	.982	.631	.358	16.75	5.40	.655
	Clerical	-.022	-.004	.004	.000	.015	.000	-.000	.004	.065	.105	.161	.163	.811	1.000	.629	.971		.938	.443	1.000	.740	.621	7.50	3.00	.575
6	Sales	-.000	.007	.044	.003	.084	.012	.012	.045	.108	.179	.324	.274	.716	1.000	.657	.914	.878		.620	1.000	.823	.383	15.67	5.06	.728
	Dealing with Situations	.095	.114	.238	.077	.379	.156	.109	.159	.259	.505	.518	.453	.683	1.000	.687	.534	.537	.709		.756	.792	.105	9.94	2.98	.499
	Service	-.019	.000	.008	.005	.057	.000	.000	.017	.099	.111	.259	.243	1.000	1.000	.852	.870	1.000	1.000	.795		1.000	.677	2.87	2.48	.434
	Etiquette	-.017	-.012	.012	-.000	.029	.000	.000	.000	.126	.276	.416	.257	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		.581	4.25	1.70	.442
	Style and Grooming	-.151	-.058	-.048	-.012	-.027	-.036	-.047	-.020	.002	.011	.024	.054	.752	1.000	.455	.468	.805	.528	.338	.875	1.000		9.55	3.75	.670
Female	Means	18.24	10.96	11.62	2.38	11.52	6.58	2.40	11.02	7.79	7.51	8.13	7.02	9.18	3.64	14.27	16.92	7.52	16.02	9.86	8.59	4.36	10.64			
	Standard Deviations	7.66	5.19	4.52	1.58	4.08	3.14	1.59	5.28	3.77	2.81	3.08	2.63	2.88	1.47	4.47	5.53	3.08	5.08	2.94	2.68	1.61	3.74			
	Split Half Reliabilities	.825	.775	.754	.405	.643	.570	.435	.789	.732	.583	.574	.486	.540	.151	.658	.632	.607	.758	.485	.524	2.17	.643			

generalization across tested capabilities. The uncorrected correlations are subject to serious attenuation from the low reliabilities of short tests. In addition, the pattern is obscured by rather wide differences in reliability among the various tests. However, when correlations are corrected for unreliability, a different kind of distortion is introduced. It is clear that some of the reliability estimates are rather gross underestimates, as revealed by the unfortunate tendency of a number of them to result in "corrected" proportions of variance in excess of 100 per cent--a patently ridiculous result which we have obscured by limiting entries to unity in the table. Nevertheless, either of the tables, or better yet, an integration of the two, reveals a relatively clear pattern suggesting a structure defined in large part by an underlying hardware-people continuum. Special relationships between measured capabilities, as they deviate from the general patterning, are discussed under the description of the different capability areas.

Vocational Capabilities and Intelligence

Students who were administered the vocational capabilities tests were also administered the Science Research Associates (SRA) Verbal (Thurstone & Thurstone, 1947) test of general intelligence. This test yields separate linguistic and quantitative scores. Correlations of these aptitude scores with areas of general vocational capabilities are shown in Table 8. It may be of interest to note that, even though the reliabilities of the general capabilities area scores are somewhat larger on the average than the published SRA reliabilities, the correlation between the SRA linguistic and quantitative scores is higher for both males and for females than is any aptitude correlation with a vocational capability area. This is true even for the "symbolic" area which is known to have heavy concentration of both linguistic and quantitative problems. The data summarized in Table 8 suggest that the capabilities measures are, indeed, covering an acquisition of knowledge which is partially independent of quantitative and linguistic aptitude as commonly measured. In particular, the hardware-oriented areas appear to be largely independent of these common measures of scholastic aptitude or intelligence. Table 40 on page 122 of the Appendix presents aptitude correlations with individual capabilities tests.

Table 8

Correlations between Aptitude Scores and Major Areas of General Vocational Capability

(757 male and 681 female high school seniors)

Area of Vocational Capability*	Males (aptitude)		Females (aptitude)	
	Linguistic	Quantitative	Linguistic	Quantitative
Mechanical	.23	.27	.25	.24
Electrical	.27	.31	.26	.25
Spatial	.40	.45	.39	.40
Chemical-Biological	.49	.38	.49	.36
Symbolic	.58	.59	.57	.57
People	.52	.39	.52	.38
	Correlation of linguistic with quantitative is .69		Correlation of linguistic with quantitative is .71	

* These are areas as defined prior to deletion of "Computing" and "Operation of Garment Equipment" and re-assignment of "Measuring Instruments," "Fluid Systems," and "Medical and First Aid."

School Courses and Intelligence

Students who took the aptitude and vocational capability tests also provided information concerning the courses they had taken--the number of semesters taken, the usual grade received, and whether they liked or disliked the course. Relationships of these course data with Linguistic aptitude test scores are shown in Table 41 on page 123 and with Quantitative aptitude test scores in Table 42 on page 124 of the Appendix.

Both male and female seniors who reported taking one or more semesters of physics, foreign languages, or chemistry scored higher than students who did not report taking these courses on both Linguistic and Quantitative tests. There was also a tendency for those seniors who took more semesters of academic electives to score higher on both aptitude tests and those students who took more non-academic electives to score lower. Grades in both academic and non-academic courses tended to be positively correlated with aptitude scores, although academic grades tended to show a higher degree of relationship. Liking versus disliking courses revealed little in the way of substantial or consistent relationships with aptitude scores.

It may be well to keep these tendencies in mind in interpreting relationships between course data and measures of vocational capability, particularly those correlated to some substantial degree with aptitude measures.

Generalization of Capabilities to New Occupations

One of our major concerns early in the project was that capabilities identified on the basis of the 31 occupations would not apply to any substantial proportion of additional occupations. Even a limited review, however, suggests that those capabilities which have been delimited by the current study have wide applicability to additional occupations. Consequently, additional occupations seeming to have especially strong loadings of requirements for particular capabilities are suggested for illustrative purposes, but no systematic attempt has been made to extrapolate the capabilities identified in this study to an additional sample of occupations.

Missing Capabilities

In contrast to the relatively obvious relevance of the identified general vocational capabilities to many occupations, the comprehensiveness of the defined array is subject to question. Indeed, we have every reason to believe that the spectrum of general capabilities defined by our original 31 occupations has "blank spots." In our more detailed descriptions of capabilities which follow, we have attempted to suggest the nature of some of the most obvious missing capabilities. Future analyses with broader occupational contexts will almost certainly suggest additional capabilities having general occupational relevance.

Occupational "Universals"

We may note the absence of certain "universal" job capabilities from our results. The assumption of prerequisite grammar school capabilities such as reading, writing, and arithmetic was noted early in the report. Despite this effort to assume such components out of the current study, our computational test seemed to be essentially another general arithmetic test.

On the other hand, there are general job capabilities, not necessarily part of elementary school subject matter, which are also missing from our formal array. Notable among these are certain universal human relations requirements such as getting along with supervisors, peers, and subordinates; communications requirements such as giving and taking instructions effectively; effective work habits such as attending to details, meeting schedules, and checking and correcting errors. These "universals" were assumed and not derived for testing.

A thread running through a number of capability areas is safety. This did not show up strongly as a homogeneous factor, but rather as an aspect of many different content areas. Even though safety capabilities seem to be determined in large part by the substantive areas of application, we would still emphasize that safety is an important general job requirement.

MECHANICAL

The "mechanical" area deals with machines and mechanical principles. It implies an organized body of knowledge concerning mechanical components and principles applied to a wide variety of industrial and home situations. This area implies a set of elementary mechanical principles having application to a variety of jobs. Also implied is knowledge of the common types of mechanical systems (both stationary and vehicular), components, and functions; with emphasis on their implications for operation, maintenance, and design. Knowledge concerning common types of tools, connectors, and fittings and their appropriate uses is also implied. Principles of safety relating to mechanical devices are involved.

Fluid systems, although also having many generic ties to the physical chemistry area, seems to fit reasonably well into the mechanical area. Measurement and measuring instruments, although having clear relationships to the quantitative symbolic area, seems best to fit within the mechanical area.

The mechanical area would seem to have special relevance to occupations such as repairman, machinist, mechanical engineer, vehicle operator, and operators of various kinds of stationary equipment. A curriculum-oriented structure and suggestive content for the mechanical area are presented in Table 9 on page 50.

Performance for both males and females was highly correlated among tests within the mechanical area--tools, mechanical systems, measuring instruments, stationary equipment operation, vehicular operation, connections and fittings, and fluid systems. Measuring instruments and stationary equipment operation revealed less relationship with each other than was revealed by other correlations among tests in the mechanical area. Correlations with the electrical, spatial, and materials-chemicals part of the chemical-biological area were relatively high. There was a marked discontinuity in degree of relationship

Table 9

General Structure for Machines and Mechanical Principles

<table>
<tr><th>Tools</th><th>Elementary Applied Principles</th><th>Analysis of Machines</th><th>Fluid Systems</th></tr>
<tr><td>• Common hand tools
• Common power equipment
• Selected special tools
• Large operating equipment (cranes, diggers, etc.)
• Delicate precision tools</td><td rowspan="3">• Leverage and lifting
• Pulleys, screws, and inclined planes
• Balance
• Transmission of force and energy
▲ friction & tension
▲ gears
▲ linkages
▲ tangential force
▲ inertia
• Vibration
• Alignment
• Filtering
• Aerodynamic principles applied to machines
• Hydraulics applied to machines
• Common mechanical symbols
• Optics and lens components</td><td>• Vehicular motion
• Bearings and shafts
• Pistons and other drive mechanisms
• Mountings
• Feed mechanisms
• Lubricating points
• Heating and binding</td><td>• Leak detection
• Solid, liquid, gas transforms
• Pressure
• Valves
• Safety devices and thermostats</td></tr>
<tr><th>Connections and Fittings</th><th colspan="2">Measurement</th></tr>
<tr><td>• Threads
• Flanges
• Solder joints
• Welds
• Packing and washers</td><td colspan="2">• Measuring instruments and their uses
• Measurement units and conversion of units
• Tolerances
• Principles of measurement and estimation</td></tr>
</table>

between mechanical tests and tests after chemicals on the hardware-people continuum. That is, the biological part of the chemical-biological area correlated substantially less highly with mechanical tests than other tests had up to that point. This lower degree of relationship remained generally true throughout the remainder of the tests. Exceptions to this were medical (first aid) and dealing with situations tests which had moderate degrees of relationship with mechanical tests. Especially noteworthy was the relatively strong correlation between vehicular operation and dealing with situations. This might well be expected since a number of situational items were derived from the traffic context.

Correlations between mechanical tests and tests at the opposite end of the spectrum--service, etiquette, and style--tended to be quite low or slightly negative.

Relationships between course data and mechanical tests are presented in Tables 43 to 49 on pages 125 to 131 of the Appendix. Male students who reported taking one or more semesters of drafting, electricity, metals, physics, and woodworking score substantially higher than those who do not report taking these courses. An insufficient number of females reported taking any of these courses except physics to yield reliable data. Females who took a semester of physics, however, did substantially better on mechanical tests than did other females. Indeed, the female physics students averaged higher mechanical scores than the means for all males, even though the means for all males tended to be substantially higher than the means on mechanical tests for all females.

With the exception of stationary equipment, both males and females who took more mathematics scored somewhat higher on mechanical tests than did those who took less mathematics. Otherwise, the relationships between amounts of course taken and test scores were rather specific to particular mechanical tests. For males, students who reported better grades in drafting and electricity had slightly higher mechanical test scores. Grades for females revealed little relationship with mechanical test scores.

For both males and females there is a slight, but relatively consistent, tendency for students who like chemistry and those who dislike English to score higher on mechanical tests. Although based on sufficiently small numbers of students to make the results merely suggestive, there seems to be some slight tendency for males who like and females who dislike sales and marketing to score higher on mechanical tests.

Relationships between course data and Garment Equipment Operation are presented in Table 66 on page 148 of the Appendix.

ELECTRICAL

The "electrical" area would seem to encompass concepts and principles of electricity, electro-mechanics, and electronics which are commonly applied in work and home situations. The sampling of occupations in the current study was such that only an incomplete scattering of such concepts and principles emerged. It was necessary, therefore, to combine all of the items having to do with things electrical into a single test. It would seem likely that, in a fuller analysis of the electrical area, a useful set of subareas might be defined. A subarea devoted to electro-mechanics might provide a convenient bridge between the mechanical area and the more purely electrical areas of electricity and electronics.

The electrical area would be likely to have special relevance for occupations such as electrician, appliance serviceman, assembler, instrument repairman, electronic technician, electrical engineer, and physicist.

A curriculum-oriented structure and suggestive content for the electrical area are presented in Table 10 on page 54. Relationships of the electricity test with course data are shown in Table 50 on page 132 of the Appendix.

Electricity was highly correlated with mechanical tests and related to other tests in much the same way as did mechanical tests. Also, relationships between electricity and course data rather closely paralleled results for mechanical tests. However, there was a suggestion of somewhat greater relatedness to general science and physics than was the case for mechanical tests. This was revealed by a tendency for both male and female students who report better grades and a liking for these courses to score slightly better on electricity than do others.

Table 10

Electrical Principles

Electro-Mechanics	Electrical	Electronic
• Common electro-mechanical devices and their functions • Translating electrical and mechanical energy • Electro-mechanical symbols	• Electrical components: functions and characteristics • Elementary circuits: functional and physical characteristics • Electrical tests • Electrical symbols • Electrical safety ▲ static electricity ▲ electricity & combustion ▲ shock ▲ capacitance ▲ wiring deterioration	• Electronic components: functions and characteristics • Simple electronic circuits • Measures and tests for electronic circuits • Electronic schematics

SPATIAL

The spatial area is concerned primarily with the application of geometric, numerical, and drawing techniques to problems of simple structural design and representation. Implied by this area is a knowledge of drawing instruments, standards, and techniques. Layout, visualization, uses for building materials, and construction methods are included. A central focus is the application of the findings and methods of geometry to drawings and structures.

This area should have special relevance to such occupations as draftsman, sheet metal worker, carpenter, model builder, skilled construction worker, civil engineer, and architect.

A curriculum-oriented structure and suggestive content for the spatial area are presented in Table 11 on page 56. The two tests representing the spatial area--layout and structures--correlated highly with each other. They also had generally high correlations with mechanical tests and with electricity. Their degree of relationship with materials was quite high and with chemicals only somewhat less. The reduction in relationship with tests after chemicals was less dramatic than was the case for mechanical and electrical tests. However, there was a general trend toward quite low correlations with tests toward the people end of the continuum.

Relationships between spatial tests and course data are presented in Tables 51 and 52 on pages 132 and 133 of the Appendix. Both male and female students who took one or more semesters of physics scored substantially higher on spatial tests than did other students. This was true to a lesser extent for chemistry. Males who took drafting and electricity also scored somewhat higher than males who did not take these courses.

Both male and female students who took more mathematics obtained higher scores on spatial tests. Females who took more foreign language scored higher, but there was little evidence that this was true for males.

Table 11

Spatial Relationships and Principles

Drawing	Structural Design	Applied Geometry
• Drawing tools and procedures • Scaling and measuring • Layout • Labeling and dimensions • Translating from objects, photographs, and other drawings • Using drawings	• Accepted standards • Maximum strength • Minimum use of materials • Maximum weather protection • Insulation • Removal of damaged structures	• Representation of points, lines, and surfaces • Analysis of structures in terms of points, lines, and planes • Positioning for ease of work and efficiency • Relative sizes of components for eventual fit • Relative size of interior and exterior surfaces • The effects of molding and deforming

Grades were somewhat more highly related to layout than to structures, and male grades showed generally higher relationships for both tests than did female grades. Higher grades in biology, general science, and mathematics were most consistently associated with slightly higher scores on both spatial tests for both sexes. For males, higher grades in drafting, electricity, and metals were also associated with higher spatial scores. There was a slight tendency for males with superior grades in woodworking to score better on layout, but not on structures. However, males who took more woodworking tended to score lower on the layout test. Females who received superior grades in social studies obtained slightly better scores on both spatial tests. There was a statistically significant, but very slight, correlation in this same direction for males.

Relationships between liking or disliking courses and spatial test scores were slight and revealed no meaningful pattern.

CHEMICAL-BIOLOGICAL

This area includes the application of elementary concepts and principles of chemistry, biology, and physics to common problems found in a variety of occupations. Principles of hygiene, chemical dangers, and toxicity are included. The characteristics, properties, and uses of common materials are appropriate content; although this subdomain of knowledge seems clearly to have important relationships to knowledge in the mechanical and spatial areas. Chemical components and reactions, biological and medical systems, and foods all seem to fit reasonably well into this area.

A great many of the chemical and biological principles would seem to draw upon computational and symbolic manipulation skills of the sort involved in the symbolic area for their full exposition and facility of application.

Some of the occupations for which the chemical-biological area seems to have special relevance are occupations such as medical technologist, medical X-ray technician, practical nurse and nurse's aid, nurse, physician, dentist, veterinarian, biologist, chemist, and chemical technician.

A curriculum-oriented structure and suggestive content for the chemical-biological area are presented in Table 12 on page 60. The tests within the chemical-biological area clearly fell into two separate groups. Materials and chemicals were strongly related to each other and, to a reduced extent, to tests in the spatial, electrical, and mechanical areas. Biological systems* and medical tests were strongly related to each other and, to a somewhat lesser extent, (although differing reliability estimates cloud the issue here) with foods. All of these tests related more strongly with tests

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* Biological systems is especially difficult to interpret since obtained reliability estimates for it are clearly too low; its correlation with a number of other tests is substantially greater than unity when corrected for attenuation.

Table 12

Chemical and Biological Principles

Materials	Chemical Components and Reactions	Biological Systems	Foods and Cooking
• Characteristics, properties, and uses of common materials • Surfaces and their covering • Some easily damaged materials	• Combustion, its products, and effects • Common laboratory and industrial procedures • Common reactants and reactions • Chemical cleaners	• Common biological and medical laboratory tests • X-ray and fluoroscope technology • Sterilization • Biological reactions to common materials, processes, and chemicals • Medical and first aid practice	• Basic food chemistry • Scheduling cooking operations • Diets • Common foods and their composition • Sanitation

toward the people end of the continuum than they did with tests toward the hardware end. Despite this clear clustering of tests within the chemical-biological area, relationships between tests from the two groups were moderately strong.

Relationships of chemical-biological tests and course data are shown in Tables 53 to 57 on pages 135 to 139 of the Appendix. Male and female students who took one or more semesters of either physics or chemistry scored higher on both materials and chemicals tests than did students who did not take these courses. Both males and females who took more mathematics scored somewhat better on materials and chemicals than did students who took less mathematics. Females, but not males, who took more foreign language scored higher on these tests.

Superior grades in biology and general science were associated with slightly higher scores on materials and chemicals tests for both males and females. Although statistically significant, the superiority of materials and chemicals scores for students with higher grades in chemistry was extremely slight. Materials and chemicals scores were somewhat higher for male physics students with better grades than for those with lower grades, but no significant relationship appeared between physics grades and scores on these tests for females. Superior grades in drafting and electricity were associated with higher materials and chemicals scores for males. Females with higher home economics grades had somewhat higher chemicals, but not materials, scores. For females, there was little evidence for any relationship between liking courses and materials or chemicals scores. For males, liking chemistry and general science and disliking health was slightly associated with higher test scores.

There was little evidence of superior test performance on foods, biological systems, or medical for students electing any or not electing any particular course; although there was a slight tendency for both male and female students with one or more semesters of chemistry or physics to score higher on the medical test. There is some evidence that males who took no or little drafting, metals, or woodworking scored slightly better on foods, biological systems, and medical tests than those who elected more of these courses. Females, but not males, who took more biology obtained higher scores on the biological systems test than those who took less.

High grades in English, biology, and social studies, are those most consistently associated with high scores on foods, biological systems, and medical tests--both for males and females. For females, high grades in home economics show only a very slight association with superior scores on these tests. High grades in food preparation have a small and (due to a small number of students) tenuous association with high scores on the foods test.

Liking for different courses revealed little in the way of substantial relationships with test scores, although there was suggestive evidence that males who disliked electricity tended to score higher on foods.

SYMBOLIC

The symbolic area includes major verbal and numerical components. The numerical component includes applications of symbol systems to work situations, facility in carrying out arithmetic operations, and arithmetic and bookkeeping conventions. The verbal component emphasizes aspects of spoken and written English which are commonly important to jobs. Elements derived from the jobs analyzed under the current study tend to emphasize clerical skills associated with the production, processing, and storage of written communications and records. A more extensive analysis would seem likely to place added emphasis on giving and taking instructions and on the preparation and presentation of reports.

The numerical component of this area would seem to have special relevance to occupations such as computer programmer, bank teller, bookkeeper, accountant, buyer, actuary, statistician, and mathematician. The verbal component would seem to have special relevance for occupations such as secretary, proofreader, copy editor, clerk, and writer.

A curriculum-oriented structure and suggestive content for the numerical component are shown in Table 13 on page 64 and similar information for the verbal component in Table 14 on page 65. The "giving instructions" and "reporting" areas are essentially missing from tests developed under this study.

Arithmetic conventions and clerical tests were highly correlated with each other. Their relationships with other tests were roughly parallel. Their relationships with people-oriented tests were from very to moderately high. Moving from their adjacent members in the biological area toward the extreme hardware end of the continuum, relationships gradually decreased from high to essentially zero.

Relationships between the two tests in the symbolic area--arithmetic conventions and clerical--and course data are shown in Tables 58 and 59 on pages

Table 13

Numerical Operations

Symbol Systems	Arithmetic Operations	Arithmetic and Bookkeeping Conventions
• Using special-purpose symbol systems • Applying rules of binary arithmetic • Using exponents • Detecting ambiguous and unambiguous arithmetic expressions	• Application to practical problems • Computing and bisecting angles • Computing lengths using geometric relationships • Fractions • Decimals, percentage, proportion • Basic arithmetic operations	• Standard procedures • Common terms • Graphs • Tables

Table 14

Verbal Communication

Giving and Taking Instructions	Reporting	Clerical
● Clarifying ambiguous instructions ● Understanding and following instructions ● Taking notes from oral instructions ● Giving effective instructions ▲ determining need ▲ determining form & length ▲ clarity, accuracy, & tone	● Report writing ▲ role of reports in business, commerce & industry ▲ gathering background ▲ defending reports ▲ selecting content ▲ selecting format ● Comprehension and expression ▲ rapid reading of sentences ▲ word recognition in reading ▲ expression of ideas in written sentences ▲ writing sentences ▲ practice in oral communication with sentences ▲ varieties of sentences ▲ functions of words in sentences	● Banking procedures ● Office routines ● Filing ● Letters

140 and 141 of the Appendix. Although analysis of the computing test has suggested that it is probably too close to being a straight arithmetic test for major domain-defining purposes of this study, it seems still to be of sufficient interest to warrant presentation of its relationships with course data in Table 60 on page 142 of the Appendix and in the brief discussion below.

Students, both male and female, who reported taking one or more semesters of sales and marketing scored consistently lower on symbolic tests then did other students, as might be predicted from their relatively low scores on aptitude tests. For males, the students who reported taking one or more semesters of physics were superior on arithmetic conventions and computing to any other group, as defined by the dichotomy of taking or not taking a particular course. Females who took physics were likewise superior on computing, but no strong differentiation among course groups held for arithmetic convention scores. For the clerical test, both males and females who took foreign language were superior, as were females who took home economics. Students who took business and commercial courses were only slightly superior on the clerical test to those who did not elect such courses, probably reflecting the tendency of students with lower intellectual abilities to elect these courses.

Students who took more business and commerical work tended to score lower on the computing test than did students who took some, but less, commercial work. Students who took more general science scored slightly lower on all three tests.

High grades in most courses were associated with high scores on symbolic tests, especially computing. Especially important for clerical were biology, business, English, foreign language, general science, music, sales, and social studies grades. For arithmetic conventions; biology, business, English, sales, and social studies grades were most highly associated with scores.

Liking or disliking courses had little association with symbolic test socres or appeared to be rather specific and scattered.

PEOPLE

This area is primarily concerned with aspects of human interaction and relations frequently encountered in jobs. It includes behavior relating to style, grooming, etiquette, and job conventions. Ethical, legal, and social criteria that govern behavior in emergencies and other nonroutine situations are also included. A subarea of "sales" is concerned with facilitating persuasive interactions within established limits or propriety. A subarea of "service" is concerned with appropriate interaction between workers and clients of all kinds. Although not explicitly included within the AIR study, aspects of effective supervision and subordinate behavior would seem logically to fall within this area.

This area would seem to have special relevance for occupations such as policeman, salesman, barber and beauty operator, proprietors of all sorts, waiter and waitress, airline hostess, and ticket agent.

A curriculum-oriented structure and suggestive content are presented in Table 15 on page 68. The tests in the human relations area--sales, dealing with situations, service, etiquette, and style--were generally highly correlated. Except for dealing with situations, they tended to drift off from these high relationships toward zero or negative relationships as correlational comparisons moved from adjacent regions of the capabilities spectrum toward the extreme hardware end of the spectrum.

Dealing with situations related to other tests across the full spectrum in essentially a constant manner (allowing for chance fluctuation and idiosyncratic relationships). This suggested the possibility that content of the situational test is heterogeneous, drawing from content across the entire spectrum. Content analysis supported this likelihood since the contingencies dealt with in the test covered quite a wide variety of situations involving mechanical, structural, and medical contexts. Our current thinking would be that dealing with situations might best be handled like safety; that is, being an important aspect of performance under many content areas. The position

Table 15

Human Relations

Behavior on the Job	Dealing with Situations	Sales	Service
• Style and grooming • Social etiquette and job conventions • Supervision	• Emergencies and contingencies • Social situations	• Assessing customers and clients • Persuasion and sales procedures • Matching customer, product, and technique • Advertising	• The client's rights • Rules of effective service

currently held on the vocational capabilities spectrum would then be reserved for content more strictly limited to inter-personal and social situations.

Relationships between people-oriented tests and course data are presented in Tables 61 to 65 on pages 143 to 147 of the Appendix. There was very little difference between human relations test scores for students who did and did not take various courses. Both male and female students who took physics did somewhat better on sales and situations than did other students--but not appreciably better on service, etiquette and style. Both male and female students who took foreign language scored slightly higher on service and etiquette than their counterparts who did not take any foreign language. Females who took home economics also scored slightly better on these tests and also on style.

Students who took more foreign language scored higher on the various human relations tests than students who took some, but less, of such courses. Differences for females were consistently larger than for males. Amounts of courses taken other than foreign language did not consistently differentiate human relations test scores.

Higher grades in many courses were associated with higher human relations test scores, although there was not a high degree of consistency across sexes or tests. In general, high grades in biology, language, the arts, business, and social studies were more strongly associated with high test scores than were high grades in mathematics and the physical sciences. General science and home economics tended to have levels of association between high grades and test scores which were intermediate between those for the other clusters of courses.

Relationships between liking or disliking courses and human relations test scores were sufficiently small or tenuous as to preclude meaningful conclusions.

PSYCHOLOGICAL PROCESSES*

The areas and subareas of general vocational capabilities as they emerged from this study were content oriented, even though categories of psychological processes were used in analyzing and describing behaviors to be measured in that study. It had been assumed that content would show up more strongly than processes in determining correlation clusters among behaviors, particularly since all of the test items used to measure behaviors were of the same form (five-choice multiple choice) and this could be expected to minimize differences among different psychological processes. In any case, failure of these process variables to show up strongly in the correlational analyses of this study does not necessarily mean that they are not relevant to general vocational capabilities. Indeed, if one accepts the weight of evidence that there exists a hierarchy of different types of learning, the diversity of different processes encompassed by the domain of general vocational capabilities suggests that a hierarchy of types of psychological processes is likely to exist within any content area of general vocational capabilities.

In general, stimulus and response aspects of performance go to define what we have called vocational content. The modes by which stimuli are converted into responses serve to define what we have called psychological processes. At the current state of our knowledge, it would be misleading to imply that we are able to draw the lines between processes and stimuli or responses with any high degree of precision. Rather, there is, for any actual behavior, a great deal of fuzziness in making these distinctions. In particular, it is difficult to draw sharp distinctions between processes and the action involved in making a response. For our present purpose, however, we will attempt to limit our process categories such that they will not imply anything more about stimuli and responses than, in some cases, whether they are essentially continuous or discrete.

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* Originally introduced and discussed on page 21. Much of the material in this and following sections was recently presented in a technical paper (Altman, 1966a). Its inclusion here is essential to place the vocational content results, which comprise the major findings of the study, in proper perspective.

In Table 16 is presented a set of general psychological processes. For each category of process there is presented a definition, an indication of the type of learning required for its establishment, and the types of errors that may be associated with the particular process.

Learning categories imply different conditions for optimum learning. Consequently, the association of learning categories with categories of psychological processes implies a great deal concerning the nature of required educational programming for any general vocational capability domain which is structured by psychological processes. In particular, if we accept Gagné's (1965) proposition that learning types are hierarchical in the sense of more complex types of having simpler types of learning as prerequisites, the association of learning categories with psychological processes has implications for the order in which material within a given content category may most advantageously be presented.

The association of error classes with psychological process categories has two major kinds of implications for educational programming of general vocational capabilities. First, the association of error types with psychological processes directly implies different educational objectives for capabilities falling in different process categories since a general purpose of education and training is to eliminate or reduce error. Second, such association enhances our understanding of the hierarchical relationships among psychological processes since classes of error for simpler processes are imbedded in more complex processes, but the more complex processes usually have additional classes of possible error.

In Figure 5 is shown a schematic representation of the hypothetical "inclusion" relationships among classes of psychological processes.

Table 16

Psychological Processes with Related Categories of Learning and Characteristic Errors

Psychological Processes	Learning Categories	Error Classes
SENSING--perceiving a difference in physical energies impinging on a single sense modality.	Classical conditioning (Gagné's Type 1: Signal Learning) may be important for alerting purposes, but this possibility seems not to have been well studied.	• Failure to attend to the locus of the signal. • Failure to perceive a signal change. • Perceiving an unchanged signal as changing. • Mistaking the direction of signal change.
DETECTING--perceiving the appearance of a target within a background field.	Instrumental conditioning (Gagné's Type 2: Stimulus-Response Learning) seems to be paramount.	• Failure to monitor the field. • Failure to perceive the target. • Falsely detecting the appearance of a target. • Associating a wrong response with the stimulus.
CHAINING or ROTE SEQUENCING--following a pre-specified order of verbal and/or motor acts.	Gagné's Type 3: Chaining and Type 4: Verbal Association.	• Omitting a step. • Inserting a step. • Changing the order of steps.
DISCRIMINATING or IDENTIFYING--perceiving the appearance of a target as distinct from other targets.	Gagné's Type 5: Multiple Discrimination.	▲ All DETECTING error classes. • Assignment to the wrong target class.
CODING--translating a perceived stimulus into another form, locus, or language; not necessarily involving the application of a sequence of logical rules.	A special case of Gagné's Type 5: Multiple Discrimination.	▲ All DISCRIMINATING error classes on the input language. • Failure to translate an input. • Translating into the wrong output symbol.
CLASSIFYING--perceiving an object or target as representative of a particular class, where the objective characteristics of targets within the class may be widely dissimilar.	Gagné's Type 6: Concept Learning.	▲ All DISCRIMINATING error classes. • Applying the wrong label to one or more target classes.

Psychological Processes	Learning Categories	Error Classes
ESTIMATING I--perceiving distance, size, and/or rate with discrete recording or responding.	Fitt's discrete case of Perceptual Motor Skill Learning (Melton, 1964).	▲All SENSING and DETECTING error classes. • Mis-estimating magnitude of target.
ESTIMATING II or TRACKING--perceiving distance, size, and/or rate change, with continuous responding.	Brigg's continuous case of Perceptual Motor Skill Learning (Melton, 1964).	• Mis-predicting target changes. • Over-estimating lag characteristics. • Under-estimating lag characteristics.
LOGICAL MANIPULATION--application of formal rules of logic and/or computation to an input as a basis for determining the appropriate output.	Gagné's Type 7: Principle Learning.	▲All CODING error classes. • Failure to locate an appropriate rule. • Use of a rule which is itself wrong. • Use of a correct, but inappropriate, rule. • Mis-application of the appropriate rule, including all CHAINING error classes.
RULE USING--executing a course of action, including one or more contingencies, by the application of a rule or principle.		
DECISION MAKING--choosing one out of a field of alternative actions in a probabilistic situation, including the following of optimum strategy in non-rote behavioral sequencing.	Gagné's Type 7: Principle Learning and Este's Probability Learning (Melton, 1964).	▲All LOGICAL MANIPULATION and RULE-USING error classes. • Failure to obtain or consider all relevant information. • Failure to identify all reasonable alternatives. • Making an unnecessary or premature decision. • Delaying a decision beyond the time it is required.

Psychological Processes	Learning Categories	Error Classes
PROBLEM SOLVING--resolving courses of action where routine application of rules for logical manipulation and decision making would be inadequate for optimum choice. This would seem to imply the integration and adaptation of existing principles into novel, specialized, or higher-order rules.	Gagné's Type 8: Problem Solving.	▲ All DECISION-MAKING error classes. • Formulating erroneous rules or guiding principles. • Failure to use available information to derive needed rules or solutions. • Accepting an inadequate solution as final.

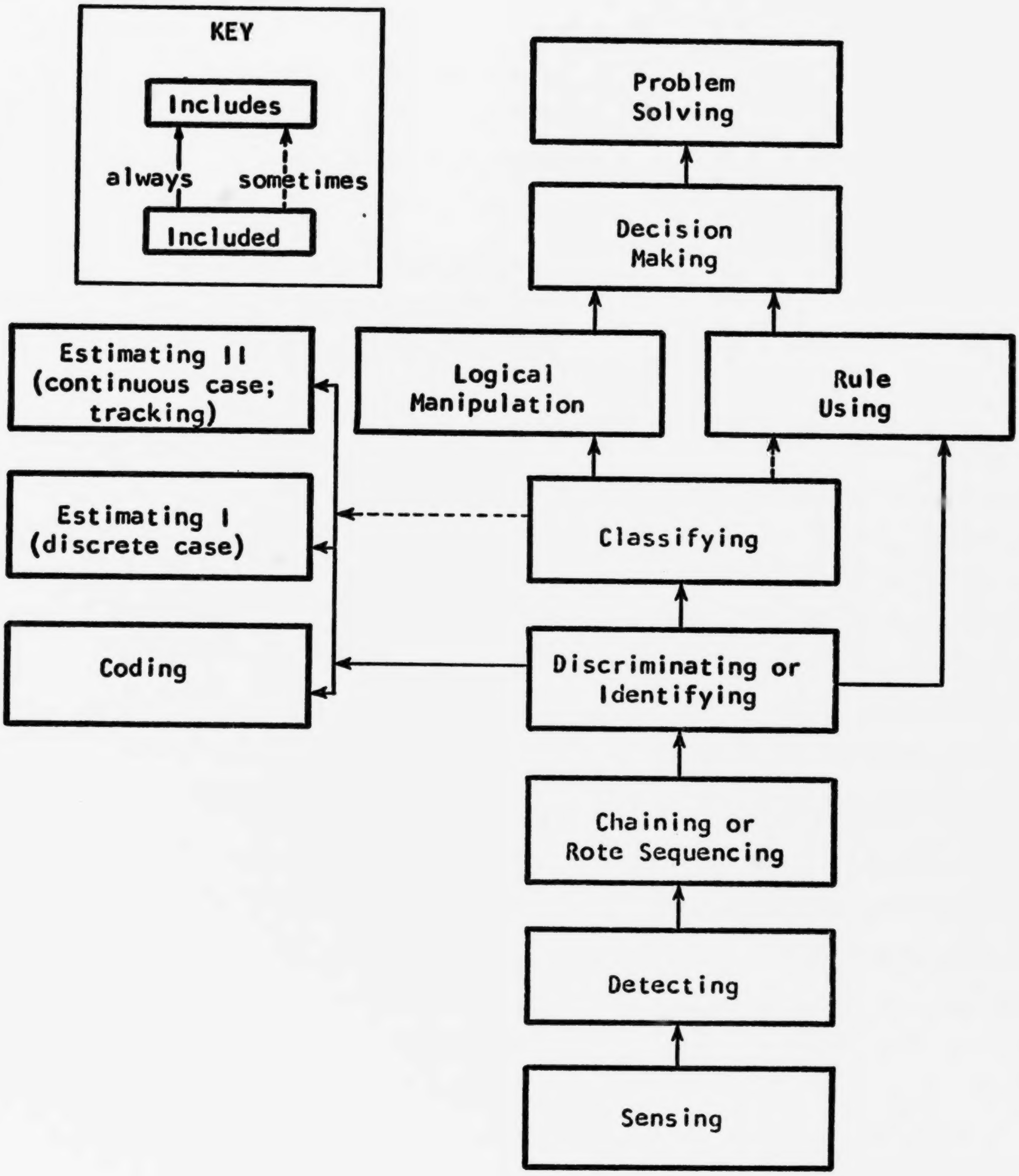

KEY
Includes
always
sometimes
Included
Problem Solving
Decision Making
Logical Manipulation
Rule Using
Estimating II (continuous case; tracking)
Estimating I (discrete case)
Coding
Classifying
Discriminating or Identifying
Chaining or Rote Sequencing
Detecting
Sensing

Figure 5. Hypothesized Inclusion Relationships among Psychological Processes.

A GENERAL CAPABILITIES DOMAIN

We have already suggested that a minimally adequate framework for describing a domain of general vocational capabilities must consider both content and psychological processes. Potentially fruitful ways of structuring both content and processes have been described. It remains to illustrate how these two major axes might be oriented.

In Table 17 we have attempted to illustrate the allocation of behaviors within a process X content category matrix. Perhaps two things are of interest concerning an attempt to structure a domain along lines suggested by Table 17. First, not only is it possible to find work-related behaviors (even dancing is work to dancing instructors) for all cells, it is possible to imagine a wealth of behaviors and compatible substructures within cells. Second, in reviewing a sample of behaviors from analyses of 31 jobs and thinking informally about a number of others, we have not found any that required excessive squeezing to fit it somewhere in the structure. Of course, at the current state of our knowledge, and perhaps inherently, there are individual work behaviors that seem to have multiple content and which fit in the grey areas or transition zones between processes.

Perhaps three points on perspective are in order here concerning a structure of the type suggested by Table 17:

1. Clearly, this is not the only way a domain of general vocational capabilities might be structured; it is simply one which seems to this writer to be most compatible with the main thrust of available evidence.
2. Even if we accept the paramount importance of psychological processes and content as axes for defining a general capabilities domain, there are many alternative ways of orienting and defining these axes.

Tabl

Sample Behaviors for Each Psychologi

Psychological Processes			
	Mechanical	Electrical	Spatial-Struc
Sensing	Perceiving a change in the sound of a motor.	Perceiving a light change intensity.	Perceiving that a changing thickness
Detecting	Perceiving a crack in a gear.	Perceiving damage to wire insulation.	Perceiving a brace not securely faste
Chaining or Rote Sequencing	Placing a washer on a bolt before tightening a nut.	Stripping wire before fastening it to a terminal.	Making a rough pen sketch before inki drawing.
Discriminating or Identifying	Identifying which gear is REVERSE.	Identifying which fuse in a central box is to be pulled.	Identifying which a drawing defines of a house.
Coding	Writing the name of a part found to be faulty.	Recording a voltage measurement.	Marking off a lengt board to be cut fr mensions on a drawi
Classifying	Differentiating gears from wheels.	Differentiating resistors from capacitors.	Recognizing targets itary significance aerial photographs.
Estimating I (discrete case)	Estimating when to stop a machine so the drive wheel will stop at a desired position.	Estimating the average voltage from a fluctuating needle.	Estimating when to spray painting over en area.
Estimating II or Tracking	Keeping a moving vehicle on the road.	Tuning a receiver to peak performance.	Drawing a freehand
Logical Manipulation	Working out the efficiency of an engine from standard formulas.	Application of Ohm's law.	Scaling a drawing.
Rule Using	Using a longer wrench if a nut does not loosen.	Checking a circuit "downstream" next after an out-of-tolerance indication.	Laying out a right if a leveling instr is not available.
Decision Making	Selecting the type of engine to be designed for a new vehicle.	Choosing nuvistors over transistors in design of a given circuit.	Selecting the style building to suggest potential customer.
Problem Solving	Developing a design for a new type of engine.	Developing a simplified model of radio interference.	Developing structur sign to eliminate supports.

Table 17

logical Process--Content Area Combination

Content Areas			
ructural	Chemical and Biological	Symbolic	People
a line is ness.	Perceiving change in the color of a solution.	Perceiving that a line of letters is not being typed straight.	Perceiving that a custome is changing position in a barber chair.
race that is stened.	Perceiving the presence of sediment in a solution.	Perceiving that an equal sign is missing from an equation.	Perceiving a skin rash.
pencil nking a	Washing a vessel before sterilizing it.	Checking all receipts before entering them on the books.	Introducing all people before starting a conference
ch line on es the width	Identifying a one litre measure in the glass equipment storage cabinet.	Discriminating the English a from the Greek alpha.	Identifying a particular individual in a crowded room.
ength of from di- rawing.	Writing the time for a chemical reaction as shown on a stopwatch.	Rewriting ten as 10.	Tallying customers as they enter a door.
gets of mil- nce from phs.	Differentiating acids from bases.	Differentiating active from passive sentence forms.	Differentiating subordinates, peers, and superior
to stop over a giv-	Estimating when a chop should be turned over in a fry pan.	Estimating how many more iterations will be required for satisfactory solution of a heuristic problem.	Estimating how much time will be required to consumate a sale.
and curve.	Focusing a microscope.	Handwriting.	Maintaining a desired distance from a dancing partner.
ng.	Computing proportionate mixes.	Computing income tax.	Applying a standard form of interaction analysis to conference transcripts.
ht triangle strument .	Partially washing a slide in cold water if a blood sample appears purple.	Showing a result as loss rather than profit if costs exceed income.	Taking pulse from temporal carotid, or femoral artery if radial pulse is weak.
yle of est to a er.	Choosing the proper spectrometer for a chemical laboratory.	Deciding on the proper statistical routine.	Choosing a sales campaign for a new product.
ctural de- e internal	Developing a more rapid technique for making cell sections.	Developing a more efficient routine for computing correlations.	Developing an improved approach to customer service

3. Even if we accept the gross structure as outlined here, it must be recognized that considerably more subdivision and substructuring are required for useful educational programming.

Let us expand on the last of the above points. Each entry in Table 17 is only a single example from a whole class of capabilities. We might find, for example, that useful topics for a course in the basic technology of machines might include:

- Tools
- Connections and fittings
- Analysis of machines
- Elementary applied principles

Elementary applied principles might further be divided into topics such as the following:

- Leverage and lifting
- Pulleys, screws, and inclined planes
- Balance
- Vibration
- Alignment
- Filtering
- Aerodynamic principles applied to machines
- Hydraulics applied to machines
- Common mechanical symbols
- Optics and lens components
- Transmission of force and energy

Within the more specific content area of "transmission of force and energy," then, we might find that it is useful to teach students principles which would be useful in the psychological process of "rule using." Such principles could include the following topics:

- How to detect improper belt tension and how to adjust such tension properly.

- How to detect and correct excessive friction in the transmission of force between gears.
- How to detect that excessive inertial forces are causing machine damage and how to dampen such forces.

Within each of the above topics, of course, there are a number of specific principles to be taught.

IMPLICATIONS

One of the problems with trying to describe a domain as broad and virgin as general vocational capabilities is that the available logical frameworks and data are not sufficient to arrive at established conclusions at this point in time. Rather, we would suggest that the implications drawn here are worthy of further development, study, and verification; not that they are established.

Curriculum Implications

The principal justification for studies of general vocational capabilities is that they may have implications for vocational curricula. A great many specific issues will emerge as one goes from efforts to define an overall structure for general capabilities to efforts to design and develop curricula which will be compatible with such a structure. It does not seem appropriate to try to forecast the nature of these issues here. It does seem appropriate to attempt to draw what seem to be the fundamental implications from the general vocational capabilities domain, as we see it now, for the design of vocational curricula.

Missing: Basic Job Technology

When one looks about, even casually, at the burgeoning efforts to improve occupationally relevant education in the United States of America, it is obvious that a number of basic problems are being attacked at various levels. Certainly, there is no lack of concern for general as well as specific vocational education, as Dr. Ray's (1966) paper will attest. Indeed, some of us who have been engaged for the last couple of years in this effort to map a domain of general vocational capabilities are actively engaged with the Quincy, Massachusetts School Department in an effort to develop a more general and flexible vocational-technical curriculum (American Institutes for Research & Quincy Public Schools, 1964). We are also engaged in an effort, as part of the program for a National Assessment of Educational Progress, to define and measure achievement of objectives for vocational education as very broadly conceived. Nevertheless, we would contend that the very core of a curriculum having general occupational relevance is missing from the experiences of most American students and still will be when curriculum efforts which have been launched to date come into use. We would call this central core of a vocational curriculum something like "basic job technology" and set as its purpose the inculcation of a broad spectrum of capabilities of the sort which we have attempted to outline in this report. Finally, we would contend that substantive progress of the magnitude appropriate to the importance of such a curriculum will require time and talent of the order devoted to modern overhauls of basic academic curricula.

A Bridge between Career Planning and Specific Job Training

We can see basic job technology as being a critical focal area in an orderly developmental process from initial vocational awareness to specific job proficiency (Altman, 1965). Not only does an appropriate educational exploitation of basic job technology hold promise of enhancing direct transfer of capability from earlier stages of learning to later and more specific training; the opportunity for self-awareness afforded by exploring one's occupationally relevant capabilities, propensities, and limitations against a broad and systematic spectrum of vocational behaviors permits valuable feedback to career choice and planning.

A Compatible Opportunity

From whatever view we have looked at the domain of general vocational capabilities, it seems in concert with accepted educational objectives. Curriculum objectives for general vocational capabilities dovetail at many points with the stuff and purpose of academic disciplines (Altman, 1966b).

In a very real sense, a curriculum for basic job technology could serve as a useful bridge between academic disciplines and more specific vocational objectives. A systematic attempt to meld the structure of general vocational capabilities to academic content would almost certainly reveal numerous opportunities to enhance the learning and retention of academic knowledge through association with concrete context.

At the other end of the bridge, we can see appropriate education in basic job technology substantially facilitating the learning of specific vocational skills and knowledge. Orderly exposure of the student to the domain of general vocational capabilities seems not only to be compatible with the guidance purposes of rational career choice and effective career planning, but holds promise as a focal operation in the unfolding of information for use in career development.

A Feasible Objective

Rather simple models have sufficed to outline a fairly extensive domain of general vocational capabilities. This would encourage us to be optimistic about the prospects of developing curricula for the public school-aged student that are not violent over-simplifications, but which do not have to be so complex as to be impractical for public school use.

A Controllable Phenomenon

Generalization within the vocational capabilities domain, insofar as we have been able to investigate it thus far, is strongly related to a meaningful external continuum of content similarity. A properly designed and applied curriculum which takes these generalization tendencies into account will place in the hands of the student and his mentors a considerable degree of deliberate control over the nature and magnitude of vocational generalization which is obtained from job technology studies.

Skimming the Cream

The main structure of the domain of general vocational capabilities is highly compatible with the extensive body of psychological knowledge which is concerned with the prerequisites for effective learning. Such explicit compatibility with this relatively well-developed area of psychotechnology means that effective programming of learning sequences within a general vocational capabilities curriculum can probably be accomplished without undue trial and error.

Learning Sequence

Major implications for training sequences are to be found in hierarchies of behavioral processes within given content areas. In particular, one must program mastery of component processes prior to training on more complex related processes which demand the components. However, although any process must be taught with some sort of stimulus and response content, once a behavior has been established for given content, it is probably possible to apply many short cuts in the learning of analogous behaviors in other content areas since there should be generalization of the psychological process involved with different contents.

An exciting possibility, and challenge, is to develop this major curriculum within a consistent framework of general findings from the psychology of learning and performance.

Methodological Implications

Job Similarity Analysis

Any serious vocational training programmer must be concerned with similarities and differences among jobs. Yet, there seems to be lacking any approach to defining job similarity which is readily relatable to learning psychology or systematic pedagogy. Certainly, the recognition of identity of tasks across jobs can be accomplished with relative ease and reliability. Such identities also have clear implications for vocational training. However, identical tasks represent similarity at a relatively gross level. If one is to be concerned with job similarity in some more general sense, the techniques for establishing such similarity are currently not very powerful. The work of Folley and Miller (1955) has suggested that even identification of identical behaviors within tasks is not very powerful in assessing job similarity.

A conception of the vocational domain along lines suggested here would seem to have promise for enhancing the meaningfulness of job-similarity analyses for vocational education. In this context, similarity among jobs could be assessed in terms of the extent to which they reveal the same pattern of assignment of behaviors to cells of a process X content matrix. Such a definition of job similarity may have more psychological and educational meaning than other approaches have had to date.

Persons concerned with systematic collection, analysis, and use of vocational guidance information have major uses for means of establishing job similarity, since they obviously cannot develop separate predictive data bases for each of the thousands of existing jobs (Cooley, 1964). Consequently, some structure such as the one here suggested could have major value in developing technology for vocational guidance.

Job and Task Description Techniques

Formal job and task description techniques are both feasible and useful to develop data bases from which to derive definitions of general vocational capabilities. It is probable that such data base and definitions can be used for meaningful educational programming. The expenditure of personnel time and money for job and task description does not seem excessive with respect to the cost of current educational practices.

Classification of Specific Job Behaviors

The framework of general vocational capabilities established in this study seems to be sufficiently broad that it may be used as a start in defining a basis for allocating behaviors derived from specific jobs and tasks to general content categories.

Programming by Content and Psychological Process

Development of educational programs was beyond the scope of the current project. However, the use of a hierarchical set of psychological processes to organize and sequence within content categories of the type identified in this study seems to warrant a major curriculum development effort on a demonstration basis.

Behavior Simulation and Correlational Analysis

The general technique of translating task steps into simulated job behaviors or test items as a basis for obtaining empirical performance data shows promise. However, the failure of routine factor analyses to yield highly meaningful descriptions of vocational capabilities and the lack of an entirely satisfactory fit of our data with pure structural models of the sort required for molar analysis (Jones, 1960) suggest the need for relatively sophisticated experimental and theoretical work prior to attempts at routine application of correlational analyses to such empirical performance data.

Experimental Studies of Generalization

The ultimate answers to many of the questions of generalization of vocational capabilities still depend upon careful studies of the development of job proficiency by persons with known levels of proficiency in other jobs. The practicality of such studies on a large scale seems doubtful, however. At the present time, the most promising route to definitive understanding of job-skill generalization would seem to be through the development of curricula and proficiency measures which reflect a defined domain such as that which is emerging in preliminary form from the present study. Measured proficiency could then be related to measures of proficiency development as individuals became skilled on specific jobs.

Theoretical Implications

Aptitudes

It is probably possible to develop a meaningful measure of aptitude within each cell of a process X content matrix. However, we would guess that aptitudes generalize across content areas for a given psychological process more readily than they generalize within a given content area from one process to another. This would suggest that a single aptitude measure which samples across contents would probably be more meaningful than one which samples across psychological processes. The correspondence between aptitudes and what we have called psychological processes may help to account for the fact that aptitude tests often predict success in jobs for which the test contains none of the job stimuli and responses.

The notions of capability, as developed within this study, undoubtedly have many generic relationships to theories of aptitude such as the one presented by Guilford (1959). Formal analysis of such relationships have not been accomplished within this project. It might, however, serve as a useful starting point toward development of a general theory of vocational competence.

Proficiency

One would, of course, expect maximum transfer of proficiency within a given cell of a process X content matrix. Also, one would anticipate that transfer would decrease as a function of distance along some underlying continuum for content such as hardware-to-people. It is also to be anticipated that an individual who can successfully perform a complex psychological process should also be able to perform its individual components, but the converse of this need not necessarily be true.

Immediately, transferable proficiency to a job situation is likely to be highly dependent upon exposure to content of a job. Time to gain full proficiency on the job and probability of ever mastering more complex aspects for which proficiency has not yet been achieved are likely to depend largely upon aptitude for the psychological processes involved.

Human Development

If we accept Bloom's (1964, p. vii) basic proposition that, "Variations in environment have greatest quantitative effect on a characteristic at its most rapid period of change and least effect on the characteristic during the least rapid period of change," it would seem highly worthwhile to look at the rates of growth in basic vocational capabilities over the life of individuals. This may suggest periods of emphasis for educational programming to have major impact on their development.

Interest and Motivation

Our analysis of the vocational domain suggests that failure to differentiate psychological processes in the programming of exposure to vocationally relevant content may result in a great deal of unnecessary irrationality in the development of vocational interests and motivations. Students might be disinclined from particular content areas, not because of any inherent disaffinities but because of excessive exposure to rote operations or from demands for processes too difficult for a given stage of development. Also, a student may develop a false assessment of his propensity for a particular psychological process due to transfer of negative valences toward a particular content which happens to be associated with the process in a given learning experience.

The likelihood that learning experiences may have negative as well as positive effects on attitudes, interests, motivation, and error tendency suggests emphasis on individualization of instruction for such critical formative periods. For, if our major objective for general vocational training is to enhance adaptability, such "negative learning" is anathema.

APPENDIX

Table 18

Occupations Judged to Have Relatively Few Employment Opportunities (Listed According to the Estimated Number of Opportunities Anticipated)

Asbestos and Insulating Worker
Airplane Mechanic
Commercial Artist
Lather
Intercity Bus Driver and Local Transit Bus Driver
Lithographer
Plasterer
Setup Man (Machine Tools)
Dental Laboratory Technician
Chemical Technician
Glazier
Central Office Repairman and Central Office Installer
Typewriter Serviceman
Telephone Operator
Aeronautical Technician
Metallurgical Technician
Cash Register Serviceman, Calculating Machine Serviceman, and Adding Machine Serviceman
Broadcast Technician
Data Processing Equipment Serviceman
Dental Hygienist
Cabinet Maker
Physical Therapist
Boiler Maker
Refinery Mechanic
Duplication and Bookkeeping Machine Serviceman
Accounting and Bookkeeping Machine Serviceman
Dictation Machine Serviceman

Table 19

Occupations Rated as Having Many and a Moderate Number of Opportunities over the Next Decade, with Worker Functions Contained in Each

(listed according to the estimated number of opportunities anticipated)

NUMBER OF OPPORTUNITIES	OCCUPATION	THINGS							DATA							PEOPLE									
		Handling	Tending	Manipulating	Operating-Controlling	Driving-Controlling	Precision Working	Setting Up	Comparing	Copying	Computing	Compiling	Analyzing	Coordinating	Synthesizing	Taking Instructions-Helping	Serving	Exchanging Information (Speaking-Signaling)	Persuading	Diverting	Instructing	Consulting	Supervising	Negotiating	Mentoring
MANY	●Secretary, Typist, & Stenographer	✓			✓		✓		✓	✓	✓	✓				✓	✓	✓							
	●Salesman & Saleswoman, Manufacturers' Salesman, Wholesale	✓	✓	✓	✓				✓		✓	✓	✓				✓	✓	✓	✓				✓	
	●Waiter and Waitress	✓		✓						✓	✓						✓								
	●Gen. Bookkeeper, & Bookkeeping & Accounting Clerk	✓		✓	✓						✓	✓				✓									
	●Over-the-Road Truck Driver and Local Truck Driver	✓				✓				✓		✓				✓		✓					✓		
	●Machine Tool Operator, & Inspector	✓			✓		✓				✓	✓	✓			✓		✓							
	●Sewing Machine Oprtr, Dressmkr, Tailor, Inspctr & Chkr	✓	✓	✓	✓	✓	✓	✓	✓	✓						✓									
	●Automobile Mechanic and Diesel Mechanic	✓		✓	✓		✓				✓	✓	✓			✓		✓							
	●Real Estate Salesman and Broker	✓							✓	✓	✓							✓	✓	✓				✓	
	●Beauty Operator	✓	✓	✓			✓					✓	✓				✓								
	●Carpenter	✓		✓	✓		✓					✓	✓			✓		✓							
MODERATE	Life Ins. Agent and Property & Cas Ins Agt & Brkr	✓							✓	✓	✓							✓	✓					✓	
	●Practical Nurse	✓		✓			✓		✓	✓	✓	✓				✓	✓	✓							
	●Cook and Chef	✓		✓			✓				✓				✓	✓									
	●Painter (Const.)	✓		✓					✓	✓	✓	✓				✓		✓							
	●Electrician, & Maintenance Electrician			✓	✓		✓				✓	✓	✓			✓		✓							
	●Plumber and Pipefitter	✓			✓		✓					✓	✓			✓		✓							
	●Teller (Bank)		✓	✓	✓					✓	✓	✓						✓							
	●Welder and Oxygen Arc Cutter	✓		✓	✓				✓	✓	✓	✓				✓		✓							
	●Draftsman	✓					✓			✓	✓		✓			✓		✓							
	Postal Clerk	✓			✓				✓	✓	✓					✓		✓							
	●Stationary Engineer, & Stationary Fireman		✓		✓		✓	✓			✓	✓	✓			✓		✓							
	●Appliance Serviceman		✓	✓	✓		✓		✓	✓		✓	✓			✓		✓							
	Mail Carrier	✓				✓			✓							✓		✓							
	●Policeman	✓		✓		✓	✓					✓	✓	✓		✓		✓							
	Bricklayer	✓		✓	✓		✓				✓	✓	✓			✓		✓							
	●Assemblers (Electronics), and Electrical Assembler	✓	✓	✓					✓	✓	✓	✓													
	●Fireman	✓							✓	✓						✓		✓							
	●Operating Engineers	✓			✓	✓			✓							✓		✓							
	●Instrument Technician, Instrument Maker, & Instrument Rprmn	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓			✓		✓							
	Tool and Die Maker	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓			✓		✓							
	●Medical X-Ray Technician	✓	✓	✓	✓		✓				✓	✓					✓	✓							
	Barber			✓			✓				✓	✓	✓				✓								
	●Medical Technologist	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓				✓	✓							
	Electronics Technician	✓		✓			✓	✓	✓	✓	✓	✓	✓			✓		✓							
	Television and Radio Serviceman	✓	✓	✓			✓		✓		✓	✓	✓			✓		✓							
	Print Pressman	✓	✓	✓	✓				✓	✓	✓	✓				✓		✓							
	Industrial Machine Repairman	✓			✓		✓		✓	✓	✓	✓	✓			✓		✓							
	Hand Compositor and Type Setter	✓		✓	✓		✓					✓	✓			✓		✓							
	Structural, Ornamental, & Reinforcing Iron Worker	✓	✓	✓	✓		✓		✓	✓	✓	✓				✓		✓							
	Claim Adjustor	✓								✓	✓	✓	✓	✓					✓					✓	
	Cement Mason	✓		✓			✓				✓			✓		✓		✓							
	●Sheet Metal Worker			✓	✓		✓	✓			✓	✓	✓			✓		✓							
	All-round Baker	✓		✓	✓		✓					✓	✓			✓		✓							
	●Programmer	✓		✓			✓			✓	✓	✓	✓		✓	✓		✓							
	●Air-Conditioning & Refrigeration Mechanic	✓		✓			✓	✓	✓		✓	✓	✓			✓		✓							
	Millwright	✓	✓	✓	✓			✓				✓	✓			✓		✓							
	Photographer	✓		✓	✓							✓	✓	✓	✓			✓							
	Telephone Installer			✓		✓	✓			✓	✓	✓	✓			✓		✓							
	Total of All Occupations	42	15	35	28	6	31	8	23	23	35	38	28	4	3	37	8	41	4	2			1	4	
	Total of 31 Selected Occupations	26	9	22	18	4	20	5	14	15	22	24	16	1	2	23	7	25	2	2			1	2	

● Selected occupations

Table 20

Occupations Rated as Having Many and a Moderate Number of Opportunities over the Next Decade, with the Major Industries to which Each Pertains

(listed according to the estimated number of opportunities anticipated)

NUMBER OF OPPORTUNITIES	OCCUPATION	INDUSTRIES: Apparel	Communication	Construction	Electric Light and Power	Equipment Manufacturing	Finance, Insurance, Real Estate	Food and Lodging	Government	Health and Welfare	Maintenance and Repair	Materials Manufacturing	Merchandising and Retail Trade	Metal Production	Personal and Protective Services	Printing & Graphic Arts	Transportation
MANY	●Secretary, Typist, & Stenographer	✓	✓	✓	✓	✓	✓		✓	✓			✓	✓			✓
	●Salesman & Saleswoman, Manufacturers' Salesman, Wholesale	✓		✓	✓	✓		✓				✓	✓	✓			
	●Waiter and Waitress							✓									
	●Gen. Bookkeeper, & Bookkeeping & Accounting Clerk	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
	●Over-the-Road Truck Driver and Local Truck Driver					✓							✓				✓
	●Machine Tool Operator, & Inspector					✓					✓			✓			
	●Sewing Machine Oprtr, Dressmkr, Tailor, Inspctr & Chkr	✓															
	●Automobile Mechanic and Diesel Mechanic					✓			✓		✓						✓
	●Real Estate Salesman and Broker			✓			✓										
	●Beauty Operator														✓		
	●Carpenter			✓		✓			✓		✓						
MODERATE	Life Insurance Agent and Property & Cas. Ins. Agt & Brkr						✓										
	●Practical Nurse									✓					✓		
	●Cook and Chef							✓									
	●Painter (Const.)			✓							✓						
	●Electrician, & Maintenance Electrician			✓	✓						✓						
	●Plumber and Pipefitter			✓							✓						
	●Teller (Bank)						✓										
	●Welder and Oxygen Arc Cutter			✓		✓					✓	✓		✓			
	●Draftsman			✓		✓								✓		✓	
	Postal Clerk								✓								
	●Stationary Engineer, & Stationary Fireman				✓			✓	✓	✓							
	●Appliance Serviceman				✓						✓		✓				
	Mail Carrier								✓								
	●Policeman								✓						✓		
	Bricklayer			✓													
	●Assemblers (Electronics), and Electrical Assembler					✓											
	●Fireman								✓						✓		
	●Operating Engineers			✓					✓								
	●Instrument Technician, Instrument Maker, & Instrument Rprmn					✓					✓	✓					
	Tool and Die Maker					✓								✓			
	●Medical X-Ray Technician									✓							
	Barber								✓						✓		
	●Medical Technologist									✓							
	Electronics Technician				✓	✓					✓						
	Television and Radio Serviceman		✓			✓					✓						
	Print Pressman															✓	
	Industrial Machine Repairman					✓					✓	✓		✓			
	Hand Compositor and Type Setter															✓	
	Structural, Ornamental, & Reinforcing Iron Worker			✓							✓						
	Claim Adjustor						✓										
	Cement Mason			✓													
	●Sheet Metal Worker			✓		✓					✓			✓			
	All-round Baker							✓									
	●Programmer																
	●Air-Conditioning & Refrigeration Mechanic				✓	✓					✓						
	Millwright					✓				✓	✓	✓		✓			
	Photographer															✓	
	Telephone Installer		✓														
	Total of All Occupations	4	4	15	8	18	6	6	11	6	17	6	5	10	5	4	4
	Total of 31 Selected Occupations	4	2	12	7	13	4	5	8	6	12	4	5	7	4	1	4

● Selected Occupations

Table 21

Sample Population Definition for Welder

The majority of welders are employed in manufacturing industries such as automobile, shipbuilding, aircraft, fabricated metal products and primary metals. The rest are employed either in construction or repair.

Included in this definition are jobs, the major duties of which are to perform work involving acetylene, electric and/or inert gas shielded arc welding and brazing processes as applied to the fabrication, maintenance and repair of metal parts or articles.

Excluded are the following:

1. Thermit, spot, seam and micro welders
2. Burners and flame cutters
3. Production line welders
4. Welding machine operators

The above are excluded because the duties performed are either of a highly specialized or assembly line nature. The former requires advanced training while the latter can be learned on the job in a short time.

Table 22

Sample Mission Statements

Practical Nurse

To assist in the care and treatment of the physically (and mentally) ill. To attend to the patient's personal appearance, comfort and emotional well-being as well as to his physical difficulties.

Salesman

To display, demonstrate, and explain the merchandise. To assist, convince the purchaser to buy the merchandise. To try to sell the consumer additional merchandise. To develop in the consumer the desire to re-order or to remain a steady customer.

Air Conditioning and Refrigeration Mechanic

The primary missions of the air conditioning and refrigeration mechanic are installing, maintaining, and repairing air conditioning and refrigeration equipment. Other, secondary, missions are listed below:

1. Directing other workers (sheet metal workers, electricians and plumbers) during the installation operation
2. Assisting customer in selection of air conditioning and refrigeration units
3. Demonstration of air conditioning and refrigeration units to customers

Table 23

Sample Functions for Practical Nurse

The nurse's main object of interest is, at all times, the patient. All of her activities are in the service of the patient, whether they be the administration of medicines and treatments, bathing, bed making, comforting, or even keeping the patient's chart. As the practical nurse works directly under the physician and registered nurses, she is required to pay close attention to their given instructions. Failure to do so may have serious ramifications. The practical nurse is a valuable source of information about her patients, and is expected to relay relevant knowledge. She, in turn, receives such information directly from the patient, sometimes in verbal exchange with the patient, sometimes by observation. Having received the information, she must know how to respond to it. In the course of giving nursing care, the practical nurse often must be able to persuade patients to cooperate with or to accept certain procedures or treatments. Other important aspects of her nursing care are diverting the patient who is depressed, bored or uncooperative and instructing the patient in the areas of health habits (e.g., brushing teeth), dietary restrictions necessary, hospital routines and procedures, and preparations for specific treatments or procedures ordered for the individual patient.

A nurse handles a good many things, including thermometers, manometers, bedpans, bed linens, water pitchers, and hypodermic needles. Several of the tasks connected with these objects (or tools) involve manipulations and, at times, a good deal of precision. Giving injections, for example, requires extreme care if accidents are to be avoided. Setting up is an integral part of every procedure that involves equipment or things.

The practical nurse, in many institutions, has some of the responsibility for maintaining hospital records. Relevant data functions thus include comparisons among various readings or of abnormal readings with a standard (temperature, etc.); copying of data onto the record forms; computing of differences in readings, dosages; and compiling of the assorted records into an ordered file. Reading written instructions is a part of planning the patient care from the written orders of the physician as well as following procedural guides in many treatments and routines.

Table 24

Sample Contingencies and Contexts Faced by a Truck Driver

1. Selects alternate routes when confronted with detours, height and weight restrictions, vehicle restrictions (in residential areas), and adverse road conditions (snow, ice, etc.).
2. Pulls over to the side of the road (if possible) when traveling up steep grades and traffic accumulates behind his vehicle because of its slow speed.
3. Notifies nearest company terminal in case vehicle breaks down or is involved in an accident.
4. In case of emergency, a driver may have to operate his vehicle for a longer period of time than allowed by I.C.C. regulations.

- -

The major differences in job contexts to which the truck driver must adapt are those involving the kind or type of vehicle they must operate (e.g., straight-in-line vs. semi-trailer) and the nature of the cargo transported. Extra precautions must be taken when the cargo transported is flammable, explosive, or toxic. The truck driver must be very careful that the cargo does not catch fire or leak (when dangerous gases or liquids are transported). There are times when the truck driver (with his helper) must unload cargo late at night when nobody is present to receive it. In such instances, the driver and helper must unload the cargo themselves and store it. When transporting government cargo, the driver may have to adhere to special government regulations. The geographical area in which the truck driver operates his vehicle influences his driving habits substantially. For example, drivers must adapt themselves to driving in snow and ice in the northern and mountain states, and hot and humid weather in the South. The nature of the terrain also affects driving.

Table 25

Sample Enumeration of Tasks for Truck Driver

Basic Tasks

1. Inspects engine
2. Inspects exterior of vehicle
3. Checks brakes
4. Inspects safety equipment
5. Operates vehicle
6. Hooks tractor and trailer
7. Unhooks tractor from trailer
8. Makes out daily log
9. Parks vehicle
10. Conduct at scene of accident
11. Makes out accident report

Specialty Tasks

1. Operation of extra-wide vehicles

Advanced Tasks

None

Ancillary Tasks

1. Loading and unloading of vehicle

Redundant Tasks

1. Checking of tires, reflectors, mirrors, etc.

Table 26

Sample Task Descriptions for Practical Nurse

Job Title Practical Nurse

Task 3, Bathes patient; Subtask 1, Gives cleansing bed bath

Object Acted Upon Patient

Information Guiding Action Recall; patient's direction; nursing procedure book

Tools Bath basin; soap in soap dish; comb or brush; bath blanket; wash cloth; face towel; bath towel; back lotion; clean patient gown; nail file, orange stick, nail clippers, applicator (optional)

Action Executes a procedure; observes patient's condition; provides companionship and diversion for patient

1. Greets patient and tells him she is going to bathe him.
2. Determines what patient can do for himself--from observation of his condition and from verbal communication about how he feels[1].
3. Screens patient from others in the room.
4. Positions patient for bath. This is usually flat on back or with the head of the bed slightly elevated[2].
5. Removes all top bed linen and covers patient with bath blanket.
6. Assists patient with oral hygiene (See Task 4).
7. Obtains bath water; 110° - 115° F or 43° - 47° C.
8. Removes patient's gown, being careful to prevent exposure by using the bath blanket.
9. Places bath towel over patient's chest.
10. Bathes and dries patient's face, neck and ears (uses applicators as necessary).

Completion Indicator Cont'd. on next page

Remarks

Table 26. (continued)

Job Title Practical Nurse

Task Page 2 of Task 3; Subtask 1

Object Acted Upon

Information Guiding Action

Tools

Action

11. Moves bath towel under arm furthest from self. Bathes in sequence the axilla, upper arm and forearm. Dries arm.

12. Bathes thoroughly hand by immersing it in the basin of water. Dries hand and cleans nails as necessary.

13. Covers bathed area with bath blanket to prevent chilling.

14. Bathes and dries in sequence the following portions of the body:
    - Other arm (nearest to nurse);
    - Chest;
    - Abdomen (uses applicator, if necessary, on umbilicus);
    - Legs and feet (immerses feet in basin);
    - Back (also gives back care as in Task 4);
    - Pubic and perineal areas[3].

Observes the following method during the entire bath:
- Protects bed with bath towel during bathing;
- Dries thoroughly;
- Covers bathed area with bath blanket to prevent chilling;

Completion Indicator Cont'd. on next page

Remarks

Table 26. (continued)

Job Title Practical Nurse

Task Page 3 of Task 3; Subtask 1

Object Acted Upon

Information Guiding Action

Tools

Action

14. (continued)

Prevents exposure or embarrassment of the patient;

Turns patient gently. If patient is helpless, obtains help for turning.

15. Takes opportunities during the bath to teach patient personal hygiene, e.g., care of feet (drying between the toes), need for emollient or lotion on dry skin, special cleansing procedures for blackheads, etc.

16. Observes any significant changes in patient's condition during the bath (rashes, lesions, decubiti, color of skin, pallor, cyanosis, edema, labored breathing, response to exercise, etc.).

17. Assists patient in putting on fresh gown.

18. Makes bed (See Task 7).

19. Assists patient in brushing or combing hair, protecting clean bed with towel.

20. Places patient's bed in comfortable position consistent with patient's orders.

Completion Indicator Cont'd. on next page

Remarks

Table 26. (continued)

Job Title Practical Nurse

Task Page 4 of Task 3; Subtask 1

Object Acted Upon

Information Guiding Action

Tools

Action

21. Ascertains whether patient has any other needs.

22. Removes bath equipment, cleans it, and returns it to proper storage area.

23. Charts bath given and any significant observation on patient's chart.

Completion Indicator Patient bathed; appropriate notations made on chart.

Remarks Contingencies on next page

Table 26. (continued)

Task 3

Contingencies

1. The task is written as for a complete bed bath. If the patient can do most of the bath himself, the nurse allows the patient to sit up in bed or dangle and complete all of the bath except the back. In this case the steps the nurse follows are generally:

   Helps patient to comfortable position
   Provides water and bath equipment
   Washes patient's back and gives back rub
   Removes water and bath equipment
   Observes patient for significant changes, signs, or symptoms
   Leaves patient in comfortable position

   In some instances, patient can wash his own face, hands, perineal region, or otherwise gives himself a partial bath. The nurse's responsibility is to see that the patient receives a complete cleansing bath without tiring the patient or causing detriment to his physical condition.

2. Cardiac and pulmonary patients usually should be bathed with the head of the bed up. Patients with back surgery may be required to be on their abdomen or sides most of the time. The practical nurse should ascertain what positions are permitted to the patient before she begins the bath.

3. Male patients unable to wash these areas themselves are bathed by orderly (if available), otherwise with tact and equanimity.

NOMENCLATURE

Dangle - to sit on the bed and allow the legs to dangle freely over the side.

Decubitus, Decubiti - bedsore(s).

Cyanosis - blueness of skin caused by lack of oxygen.

Table 26. (continued)

Job Title Practical Nurse

Task 3, Bathes patient; Subtask 2, Gives tub bath

Object Acted Upon Patient

Information Guiding Action Recall; doctor's order; patient's direction; nursing procedure book

Tools Soap in soap dish; wash cloth; bath towel; face towel; patient's gown; bath thermometer; hand bell; chart

Action Executes a procedure; instructs patient

1. Insures that patient will have privacy in the tub ("Do not disturb" sign on door, screens, etc.).
2. Fills tub approximately 1/3 full of water (maximum temperature 115° F or 47° C). Water temperature preference should be ascertained from patient.
3. Escorts patient to tub.
4. Assists patient to undress, being careful not to overly expose him.
5. Assists patient into tub; insures everything is within reach.
6. Places hand bell within reach; instructs patient to signal for assistance.
7. Assists in bathing, if necessary; otherwise may leave room if patient is able to be alone and prefers it.
8. Instructs patient in personal hygiene measures as needed.
9. Observes changes or signs and symptoms of patient as in Subtask 1 (bed bath).

Completion Indicator Cont'd. on next page

Remarks

Table 26. (continued)

Job Title Practical Nurse

Task Page 2 of Task 3; Subtask 2

Object Acted Upon

Information Guiding Action

Tools

Action

10. Assists patient from tub and helps patient dry self and dress (if necessary).

11. Escorts patient to his unit.

12. Cleans tub.

13. Charts tub bath given in appropriate place on chart.

Completion Indicator Patient bathed; appropriate notations made on chart

Remarks Precautions:

1. Patient should be instructed not to touch electrical equipment while he is in the water;
2. Bathroom should be well ventilated;
3. Bathroom door should not be locked or, if locked, there should be access by the nurse from the outside;
4. Usually there must be a doctor's written order for a tub bath;
5. Bathtub should be equipped with non-skid mat or comparable improvisation (e.g., a quilted pad may be placed in the tub).

Table 27

Sample Task Descriptions for Sheet Metal Worker

Job Title Sheet Metal Worker

Task 4, Punching sheet metal; Subtask 1, Use of solid punch

Object Acted Upon Sheet metal (various)

Information Guiding Action Recall

Tools Solid punch, hammer, lead cake, wooden block, mallet

Action Executes a procedure

1. Positions sheet metal on workbench.
2. Places backing (lead cake, heavy sheet metal, or end grain of a block of wood) under area where hole is to be punched.
3. Locates position of hole to be punched (from previous layout).
4. Selects punch.
5. Positions punch on sheet metal.
6. Strikes punch with a medium blow using a ball peen hammer.
7. Raises punch to check if punch is evenly centered.
8. Positions punch in impression.
9. Strikes punch with sharp blows until metal is punched.
10. Repeats procedure as necessary.
11. Turns sheet metal over (burr side up).
12. Flattens sheet metal smooth with mallet.

Completion Indicator Size and appearance of hole

Remarks

Table 27. (continued)

Job Title Sheet Metal Worker

Task 4; Subtask 2, Use of hollow punch

Object Acted Upon Sheet metal (various)

Information Guiding Action Recall

Tools Hollow punch, hammer, lead cake, wooden block, mallet, compass

Action Executes a procedure

1. Executes steps 1 through 4 as stated in Task 4; Subtask 1.
2. Scribes a circle on sheet metal, having a diameter slightly larger than that of the hole of the punch.
3. Positions punch directly in center of scribed circle.
4. Executes steps 6 through 12 as stated in Task 4; Subtask 1.

Completion Indicator Size and appearance of hole

Remarks

Table 27. (continued)

Job Title Sheet Metal Worker

Task 4; Subtask 3, Use of hand lever punch

Object Acted Upon Sheet metal (various)

Information Guiding Action Recall, previous layout

Tools Hand lever punch, screwdriver

Action Executes a procedure

1. Selects punch and die.
2. Unscrews die with screwdriver or key furnished with punch.
3. Opens punch by lifting upper lever.
4. Unscrews threaded collar.
5. Lifts punch from collar (if another size is in collar).
6. Inserts desired punch in collar.
7. Screws on threaded collar.
8. Depresses lever to normal position.
9. Inserts and screws desired die into positions.
10. Turns die with screwdriver so that the end of the punch enters the die approximately 1/16" when levers are in normal or closed position.
11. Opens punch.
12. Inserts sheet metal into punch.
13. Centers punch (centering point of punch is placed in the prick point made during layout).
14. Presses down on upper lever to punch hole.

Completion Indicator Size and appearance of punched hole

Remarks The hand lever punch can be used to punch holes a uniform distance from the edge of the metal without previous layout

Table 28

Sample Tasks for Computer Programmer

Job Title Programmer

Task 2, Flow charting of the problem; Subtask 1, Expresses the problem in general terms

Object Acted Upon Paper

Information Guiding Action Dimensions of the problem; computer capacity; recall; oral and written instructions

Tools Pencil, ruler, templates

Action Summarizes the problem graphically; executes a procedure

1. Depicts flow of major aspects of the data.
2. Draws diagrams containing these data.
3. Labels diagrams.

Completion Indicator Problem is graphically sketched in general terms

Remarks

Table 28. (continued)

Job Title Programmer

Task 2; Subtask 2, Refines the flow chart into detailed machine operations

Object Acted Upon Paper

Information Guiding Action Dimensions of the problem; computer capacity, recall; oral and written instructions; general flow chart

Tools Pencil, paper, rules, symbols

Action Executes a procedure

1. Diagrams input statements.
2. Determines flow of input statements.
3. Plans loops and repetitions of input statements.
4. Schematically outlines questions which must be asked on the path to the solution of the major problem.
5. Plans alternative modes of action that are contingent upon answers to questions (See 4).
6. Determines in diagram which aspects of the computer will control which parts of the problem.
7. Allows for transfer of control from one part of the machine to the next.
8. Sketches on diagram all commands that computer is to execute.
9. Plans sequence of command executions.
10. Determines what output statements are to be made accessible.
11. Specifies the points in the program at which output statements are to be printed.

Completion Indicator Sketched diagram seems to contain all elements of the problem to be programmed

Remarks Again, as in Task 1, the programmer's participation in flow charting varies considerably. Sometimes the programmer received the diagram and flow chart and his task is merely to code into a machine language

Table 29

Types of Psychological Processes and Testing Implications

PROCESSES	IMPLICATIONS
Sensing--perceiving a difference in physical energies impinging on a single sense modality. Detecting--perceiving the appearance of a target within a background field.	Generally not readily amenable to training and of little or no significance to general skill determination.
Discriminating or identifying--perceiving the appearance of a given target as distinct from other similar targets. Includes most association of nomenclature and locations with required job operations. Coding--translating a perceived stimulus into another form, locus, or language, not necessarily involving the application of a sequence of logical rules.	Important for general skill analysis and relatively easy to measure. However, requires careful attention to stimulus representation in the stem. Representation of dynamic aspects presents special problems.
Classifying--perceiving an object or target as representative of a particular class, where the objective characteristics of targets within the class may be widely dissimilar.	Likely to be a frequently occurring process. Representation usually calls for a question requiring the identification of a function category for objects of different appearance, or the assignment of one of these objects to such a category.
Estimating--perceiving distance, size, and/or rate without the application of measurement instruments.	Tends to be involved in psychomotor performance, which is difficult to represent without apparatus. Static estimation can be represented, but dynamic aspects can probably not be represented adequately on paper and pencil tests.
Chaining or rote sequencing--following a prespecified order in carrying out a procedure.	Tends to involve highly job-specific knowledge which would not be appropriate for testing with non-specialists. However, some principles and concepts which are suitable for testing may facilitate learning and enhance reliability on the job even though they may be inadequate to support sequencing in themselves.
Logical manipulation--application of formal rules of logic and/or computation to an input as a basis for determining the appropriate output. Rule using--executing a course of action by the application of a rule or principle. Decision making--choosing one out of a field of alternative actions, including the following of optimum strategy in non-rote behavioral sequencing. Problem solving--resolving courses of action where routine application of rules for logical manipulation and decision making would be inadequate for an optimum choice. This would seem to imply the integration and adaptation of existing principles into novel, specialized, or higher-order rules.	Should be highly amenable to paper and pencil testing.

Table 30

Types of Responses and Testing Implications

Responses	Implications
Writing.	Writing is assumed to be a grammar school skill not suitable for testing as part of this project. However, knowledge of what to write and form of expression may be appropriate.
Typing.	Typing appears to be a specialized manual skill which is not suitable for direct testing as part of this project. However, some of the discriminations involved in typing may be quite suitable for testing.
Drawing.	There are many aspects of drawing responses that are appropriate for testing.
Speaking-gesturing.	It is assumed that ability to speak and gesture has been achieved by the time of grammar school graduation. Vocational argot and signals may be appropriate for testing, however.
Connecting-disconnecting.	Connecting and disconnecting of standard fittings and plugs are assumed to be in the repertory of most adults, almost regardless of training. However, there may be knowledges that would help to avoid common errors such as threading.
Assembling-disassembling.	Assembling responses as such are probably much less demanding of trainable skills that are the discrimination and chaining processes with which they may be associated. However, there may be some concepts and principles that would support putting things together and taking them apart.
Operating controls.	The nature of the response is ordinarily determined by the design of the control involved. In almost all cases the manipulation of the control itself does not require trained skills, although there may be notable exceptions worth testing. Identification of the proper control and indication of response adequacy are much more likely to be fruitful for testing.
Positioning-carrying.	These gross responses are of testing interest only insofar as they can be supported by principles which minimize injury and damage.
Changing location.	Moving about the work place is of testing interest only insofar as it involves safety precaution.
Manipulating tool.	There are many aspects of tool manipulation that are appropriate for testing, particularly the discriminations which may be required.

Table 31

Format for Analysis of Measurable Behaviors (with an example of part of a sheet metal task)

Job Title: Analyst: Date:

J & T Description Codes	Performance to be measured (should include identification of the source of information; i.e., section of general job description, task, etc.)	Psychological Processes*									Responses								
		Discriminating	Classifying	Coding	Estimating	Chaining	Logical Manipulation	Rule Using	Decision Making	Problem Solving	Writing-Typing	Drawing	Speaking-Gesturing	Connecting-Disconnecting	Assembling-Disassembling	Operating Controls	Positioning-Carrying	Changing Location	Manipulating Tool
4.	Punching sheet metal, supplemented by nomenclature section of job description. Selecting the proper punch.								X										
4.1.7	Checking to ensure pre-punch detent is centered for desired hole.				X														
4.1.12 4.2.4	Smooths metal as final step.					X													
4.2.3	Places punch in center of circle.				X														X
4.1.3 4.2.1	Translates punch on drawing to position metal			X															
	Detects that hole is appropriately rounded and sized (completion indication on all sub-tasks).	X			X														

*Sensing and detecting are not included because they are assumed to yield no measurable characteristics.

Table 32

Examples of Kinds of Items which Appear in Tests to Establish General Vocational Capabilities

- *A police patrolman is being driven by another patrolman to the place where he is to start his patrol on foot. He spots a pickpocket. What should he do?*

  a. call headquarters to send someone to handle the case and go on to his beat

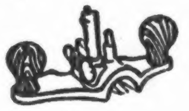
  b. find the patrolman who covers that beat and report the crime to him

  c. go to his beat and send the driver back to handle the case

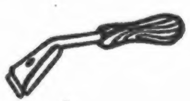
  ▷*d. stop and deal with the crime*

  e. catch the pickpocket and take him to the patrolman's beat

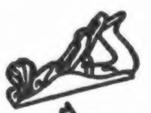
- *Which one of the tools below should a carpenter use to smooth and straighten the edge of a board?*



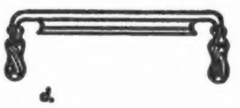
a.



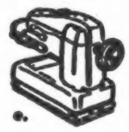
b.



▷*c.*



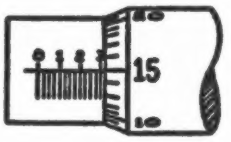
d.



e.

- *From the picture below, select the correct measurement indicated on the micrometer caliper.*

  ▷*a. .315*
  b. .340
  c. .345
  d. .350
  e. .355



- *A firefighting company wants to lay hose from the fire hydrant to the fire. What should they do first after the fire truck stops at the fire hydrant?*

  a. estimate the amount of hose needed to fight the fire

  b. start stretching the hose toward the building on fire

  c. put the hose clamp on the hose behind truck

  ▷*d. pull some of the hose off the truck*

  e. attach the nozzle to the hose

- *A bookkeeper takes a trial balance and finds there is a difference of $50 between the debits and the credits. He checks each $50 entry in the accounts and does not find an error. What should he do next?*

  ▷*a. look for a $25 entry posted in the wrong column (for example, in the debit column instead of the credit column)*

  b. look for a $100 entry incorrectly posted in the larger column

  c. subtract $50 from one of the accounts to make the books balance

  d. look for a $10 and a $15 entry posted in the credit column

  e. report the error to his supervisor

Table 33

Mean Sex Differences on Original Occupational Tests (9th grade through junior college: 2662 males and 2610 females)

Job	Variable	Male Mean	Female Mean	Smaller/ Larger	Type	Male Reliability	Female Reliability
Air Conditioning and Refrigeration Mechanic	1	2.71	1.20	.44	M	.417	.051
	2	1.04	0.60	.58	M	.160	.057
	3	1.74	1.28	.74	M	.375	.351
	4	2.10	1.29	.61	M	.251	.244
	Σ	7.59	4.37	.58	M		
Appliance Serviceman	5	1.36	0.63	.46	M	.315	.210
	6	2.64	1.90	.72	M	.434	.095
	7	5.61	4.35	.78	M	.437	.341
	Σ	9.61	6.88	.72	M		
Assemblers	8	3.36	2.01	.60	M	.367	.293
	9	1.52	1.00	.66	M	.202	.132
	10	2.28	1.36	.60	M	.369	.280
	Σ	7.16	4.37	.61	M		
Auto and Diesel Mechanic	11	1.83	0.73	.40	M	.505	.184
	12	3.43	1.82	.53	M	.538	.375
	13	4.49	1.90	.42	M	.483	.301
	Σ	9.75	4.45	.46	M		
Beauty Operator	14	1.24	2.28	.54	F	.095	.316
	15	2.31	4.51	.51	F	.296	.098
	16	2.42	3.83	.63	F	.359	.182
	Σ	5.97	10.62	.56	F		
Bookkeeper	17	1.43	1.57	.91	F	.145	.196
	18	2.17	2.62	.83	F	.108	∓001
	19	4.32	5.22	.83	F	.486	.455
	Σ	7.92	9.41	.84	F		
Carpenter	20	1.82	1.10	.60	M	.263	.231
	21	3.13	2.18	.70	M	.516	.345
	22	4.00	3.05	.76	M	.437	.390
	Σ	8.95	6.33	.71	M		
Cook and Chef	23	0.40	0.59	.68	F	.425	.439
	24	7.60	9.16	.83	F	.401	.430
	Σ	8.00	9.75	.82	F		
Draftsman	25	3.62	2.88	.80	M	.511	.496
	26	1.90	1.34	.71	M	.292	.156
	27	3.40	2.58	.76	M	.545	.455
	Σ	8.92	6.80	.76	M		
Electrician	28	0.88	0.64	.73	M	.295	.263
	29	2.51	2.02	.80	M	.362	.169
	30	3.07	2.07	.67	M	.552	.418
	31	1.61	0.94	.58	M	.396	.093
	Σ	8.07	5.67	.70	M		
Fire Fighter	32	3.70	3.18	.86	M	.314	.169
	33	2.36	2.09	.89	M	.249	.202
	34	3.13	2.60	.83	M	.273	.065
	Σ	9.19	7.87	.86	M		
Instrument Technician	35	2.06	1.03	.50	M	.418	.139
	36	2.32	1.66	.72	M	.222	.253
	37	1.57	0.92	.59	M	.127	.195
	38	2.55	1.43	.56	M	.376	.199
	Σ	8.50	5.04	.59	M		
Machine Tool Operator and Machinist	39	3.50	1.59	.45	M	.285	.141
	40	2.52	1.56	.62	M	.497	.419
	41	2.67	1.75	.66	M	.383	.220
	Σ	8.69	4.90	.56	M		
Medical Technologist	42	2.99	2.47	.83	M	.373	.338
	43	3.82	3.85	.99	F	.354	.250
	44	1.66	1.80	.92	F	.285	.256
	Σ	8.47	8.12	.96	M		
Medical X-Ray Technician	45	3.13	3.51	.89	F	.499	.355
	46	1.34	1.37	.98	F	.299	.165
	47	1.71	1.72	.99	F	.339	.246
	Σ	6.18	6.60	.94	F		
Operating Engineer	48	0.69	0.59	.86	M	∓091	.042
	49	1.06	0.73	.69	M	.072	.022
	50	7.18	4.77	.66	M	.521	.346
	Σ	8.93	6.09	.68	M		
Painter	51	1.82	1.78	.98	M	.233	.368
	52	3.33	2.91	.87	M	.533	.380
	53	3.33	3.24	.97	M	.156	.300
	Σ	8.48	7.93	.94	M		
Plumber and Pipefitter	54	1.74	1.36	.78	M	.302	.343
	55	4.38	3.79	.87	M	.405	.291
	56	2.98	1.55	.52	M	.539	.143
	Σ	9.10	6.70	.74	M		
Policeman	57	1.84	1.92	.96	F	∓052	.020
	58	1.03	1.11	.93	F	.222	.226
	59	5.02	5.04	1.00	F	.137	.145
	Σ	7.89	8.07	.98	F		
Practical Nurse	60	2.54	2.87	.89	F	.080	.103
	61	2.33	3.09	.75	F	.426	.297
	62	1.68	2.00	.84	F	.222	∓110
	63	1.71	2.15	.80	F	.122	.137
	Σ	8.26	10.11	.82	F		
Programmer	64	3.59	3.43	.96	M	.622	.593
	65	0.78	0.70	.90	M	.467	.510
	66	1.43	1.48	.97	F	.396	.451
	67	1.03	1.00	.97	M	∓072	∓088
	Σ	6.83	6.61	.97	M		
Real Estate Salesman and Broker	68	1.36	1.56	.87	F	.101	∓242
	69	0.93	1.17	.79	F	.202	.010
	70	0.91	1.12	.81	F	.328	.271
	71	3.35	3.83	.87	F	.348	.362
	Σ	6.55	7.68	.85	F		
Salesman	72	5.49	6.32	.87	F	.373	.469
	73	1.89	2.24	.84	F	.282	.064
	Σ	7.38	8.56	.86	F		
Sheet Metal Worker	74	1.96	1.29	.66	M	.194	.159
	75	1.98	1.42	.72	M	.423	.286
	76	2.44	2.15	.88	M	.104	.220
	77	1.54	1.03	.67	M	.304	.154
	Σ	7.92	5.89	.74	M		
Secretary, Typist, Stenographer	78	1.97	2.44	.81	F	.259	.239
	79	2.76	3.77	.73	F	.171	.240
	80	1.95	2.68	.73	F	.336	.194
	Σ	6.68	8.89	.75	F		
Sewing Machine Operator, Dressmaker, Tailor	81	1.49	3.18	.47	F	.278	.400
	82	2.16	3.78	.57	F	.163	.169
	83	1.67	3.06	.55	F	.303	.123
	Σ	5.32	10.02	.53	F		
Stationary Engineer	84	3.49	2.29	.66	M	.357	.298
	85	1.46	0.68	.47	M	.052	∓004
	86	1.99	1.59	.80	M	.152	.281
	87	1.59	0.98	.62	M	.244	.049
	Σ	8.53	5.54	.65	M		
Teller	88	0.72	0.69	.96	M	∓030	.057
	89	5.81	6.62	.88	F	.525	.325
	90	1.94	2.38	.82	F	.338	.035
	Σ	8.47	9.69	.87	F		
Truck Driver	91	2.27	1.78	.78	M	.360	.096
	92	2.42	1.40	.58	M	.221	.208
	93	3.37	3.03	.90	M	.201	.113
	Σ	8.06	6.21	.77	M		
Waiter and Waitress	94	0.32	0.38	.84	F	.020	∓002
	95	0.24	0.39	.62	F	.334	.464
	96	5.48	7.17	.76	F	.462	.395
	Σ	6.04	7.94	.76	F		
Welder and Oxygen Arc Cutter	97	5.06	3.06	.60	M	.357	.385
	98	2.44	1.62	.66	M	.192	.087
	99	1.76	1.24	.70	M	.188	.063
	Σ	9.26	5.92	.64	M		

Table 34

Mean Sex Differences for Seniors
(based on 757 males and 681 females)

Variable	Area	Means			
		Male	Female	S/L	Type
Fluid Systems	Chemical	3.41	2.67	.78	M
Mechanical Systems	Mechanical	14.34	11.36	.79	M
Electricity	Electrical	13.90	11.01	.79	M
Tools	Mechanical	23.27	18.73	.80	M
Stationary Equipment Operation	Mechanical	3.60	2.96	.82	M
Connections and Fittings	Mechanical	8.44	6.97	.83	M
Measuring Instruments and Measurement	Symbolic	13.61	11.61	.85	M
Layout and Visualization	Spatial	9.02	7.79	.86	M
Vehicular Operation	Mechanical	13.06	11.52	.88	M
Structures	Spatial	9.24	8.19	.89	M
Chemicals	Chemical	7.98	7.14	.89	M
Materials	Chemical	9.04	8.13	.90	M
Computing	Symbolic	14.00	13.57	.97	M
Medical	People	15.25	15.06	.99	M
Dealing with Situations	People	9.94	9.86	.99	M
Clerical	Symbolic	7.50	7.52	1.00	F
Arithmetic Conventions	Symbolic	16.75	16.91	.99	F
Sales	People	16.15	16.53	.98	F
Etiquette	People	4.25	4.35	.98	F
Biological Systems	Chemical	4.08	4.22	.97	F
Foods and Cooking	Chemical	8.78	9.18	.96	F
Garment Equipment	Mechanical	3.82	4.03	.95	F
Service	People	7.87	8.58	.92	F
Style and Grooming	People	9.55	10.64	.90	F

Table 35

Mean Sex Differences for Ninth Grade through Junior College (based on 2662 males and 2610 females)

Variable	Area	Means Male	Female	S/L	Type
Tools	Mechanical	25.06	15.53	.62	M
Mechanical Systems	Mechanical	14.66	9.80	.67	M
Fluid Systems	Chemical	3.49	2.34	.67	M
Measuring Instruments and Measurement	Symbolic	13.78	9.73	.71	M
Electrical	Electrical	13.91	9.99	.72	M
Stationary Equipment Operation	Mechanical	3.75	2.82	.75	M
Connections and Fittings	Mechanical	8.72	6.53	.75	M
Vehicular Operation	Mechanical	12.98	9.85	.76	M
Layout and Visualization	Spatial	8.93	7.17	.80	M
Structures	Spatial	9.00	7.67	.85	M
Materials	Chemical	8.68	7.61	.88	M
Chemicals	Chemical	7.70	6.94	.90	M
Computing	Symbolic	13.11	12.48	.95	M
Dealing with Situations	People	9.33	9.41	.99	F
Medical	People	13.59	15.28	.89	F
Arithmetic Conventions	Symbolic	14.21	16.14	.88	F
Sales	People	13.70	16.40	.84	F
Foods and Cooking	Chemical	7.69	9.27	.83	F
Service	People	6.92	8.54	.81	F
Etiquette	People	3.66	4.65	.79	F
Clerical	Symbolic	6.09	7.91	.77	F
Biological Systems	Chemical	3.47	4.52	.77	F
Style and Grooming	People	7.74	12.47	.62	F
Operation of Cleaning, Service, Light Garment Equipment	Mechanical	2.79	5.36	.52	F

Table 36

Obtained Correlations between Capabilities Tests for Students from 9th Grade through Junior College

(Results for 2662 males shown above the diagonal and for 2610 females below the diagonal. Tests are ordered according to relative male versus female superiority.)

																									Male		
	Tools	Mechanical Systems	Fluid Systems	Measuring Instruments	Electricity	Stationary Equipment Operation	Connections and Fittings	Vehicular Operation	Layout and Visualization	Structures	Materials	Chemicals	Computing	Dealing with Situations	Medical	Arithmetic Conventions	Sales	Foods and Cooking	Service	Etiquette	Clerical	Biological Systems	Style and Grooming	Garment Equipment Operation	Means	Standard Deviations	Split Half Reliabilities
Tools		.766	.565	.714	.703	.567	.677	.653	.576	.585	.633	.546	.420	.438	.499	.371	.338	.393	.276	.253	.307	.336	.270	.285	24.20	7.69	.836
Mechanical Systems	.606		.589	.724	.730	.541	.664	.700	.571	.601	.670	.587	.455	.491	.554	.470	.430	.431	.368	.301	.372	.383	.309	.314	14.14	5.12	.730
Fluid Systems	.437	.459		.549	.570	.456	.535	.532	.441	.479	.549	.521	.440	.404	.504	.411	.401	.380	.316	.260	.341	.340	.292	.285	3.17	1.66	.413
Measuring Instruments	.551	.543	.385		.710	.473	.641	.665	.649	.605	.661	.575	.585	.508	.578	.521	.472	.461	.409	.357	.445	.396	.313	.264	13.78	4.36	.715
Electricity	.593	.625	.436	.557		.497	.659	.631	.614	.632	.679	.636	.549	.475	.593	.536	.500	.460	.420	.336	.448	.434	.314	.350	13.91	5.57	.809
Stationary Equipment Operation	.434	.465	.368	.348	.440		.512	.492	.424	.427	.462	.459	.338	.347	.398	.317	.292	.292	.253	.214	.264	.252	.264	.288	3.02	1.66	.394
Connections and Fittings	.574	.566	.452	.507	.590	.459		.600	.580	.584	.611	.535	.491	.442	.511	.427	.398	.392	.339	.286	.373	.356	.294	.303	8.19	3.25	.592
Vehicular Operation	.531	.555	.378	.571	.547	.374	.492		.563	.588	.617	.542	.513	.560	.572	.504	.491	.427	.415	.352	.423	.339	.312	.284	12.98	4.11	.649
Layout and Visualization	.471	.456	.318	.567	.515	.327	.488	.474		.590	.604	.516	.599	.445	.531	.481	.465	.402	.376	.356	.424	.367	.296	.276	8.93	3.68	.710
Structures	.494	.489	.336	.539	.549	.307	.482	.510	.534		.610	.530	.509	.494	.546	.508	.501	.441	.418	.354	.446	.396	.342	.316	8.22	2.87	.581
Materials	.482	.496	.359	.534	.492	.311	.426	.489	.503	.508		.645	.577	.536	.654	.548	.566	.524	.470	.398	.473	.439	.358	.333	8.68	3.45	.650
Chemicals	.513	.542	.409	.518	.566	.383	.493	.502	.471	.482	.554		.524	.454	.618	.549	.518	.501	.422	.355	.454	.437	.360	.373	7.56	2.84	.533
Computing	.316	.334	.228	.515	.365	.217	.337	.403	.536	.427	.449	.395		.498	.596	.629	.582	.463	.472	.414	.570	.371	.317	.302	13.04	5.53	.773
Dealing with Situations	.227	.251	.154	.304	.234	.114	.191	.337	.274	.345	.375	.317	.402		.577	.524	.539	.443	.457	.447	.438	.289	.309	.256	9.33	3.07	.538
Medical	.381	.404	.265	.487	.392	.237	.330	.456	.432	.467	.562	.516	.496	.514		.642	.645	.575	.564	.457	.577	.498	.414	.384	12.85	4.81	.719
Arithmetic Conventions	.343	.408	.255	.443	.425	.231	.321	.468	.417	.465	.478	.431	.562	.451	.542		.715	.536	.575	.455	.634	.440	.404	.375	14.21	5.56	.708
Sales	.253	.295	.171	.413	.324	.136	.235	.385	.402	.421	.506	.409	.564	.543	.615	.663		.532	.617	.491	.628	.424	.388	.328	13.31	4.99	.752
Foods and Cooking	.273	.267	.168	.338	.269	.140	.218	.331	.306	.348	.426	.353	.413	.451	.508	.465	.524		.491	.379	.479	.433	.398	.364	7.69	2.73	.502
Service	.199	.217	.112	.307	.238	.108	.168	.299	.314	.326	.404	.313	.453	.448	.525	.514	.602	.502		.424	.505	.347	.349	.276	6.92	2.48	.426
Etiquette	.183	.181	.086	.279	.202	.086	.162	.278	.268	.297	.346	.273	.376	.423	.427	.418	.465	.401	.417		.404	.283	.299	.212	3.66	1.61	.313
Clerical	.285	.301	.172	.386	.320	.144	.245	.386	.390	.404	.429	.365	.548	.462	.536	.623	.644	.457	.506	.401		.376	.372	.322	6.09	2.80	.574
Biological Systems	.303	.323	.196	.351	.318	.190	.236	.338	.335	.368	.402	.379	.325	.333	.458	.396	.432	.387	.376	.286	.357		.360	.325	2.96	1.42	.324
Style and Grooming	.272	.263	.127	.362	.275	.162	.235	.365	.358	.390	.420	.354	.425	.468	.545	.487	.554	.515	.538	.425	.523	.394		.441	7.74	2.85	.447
Garment Equipment Operation	.257	.270	.168	.318	.297	.189	.242	.320	.342	.362	.380	.337	.377	.397	.485	.425	.495	.434	.412	.348	.447	.344	.560		2.73	1.63	.371
Female Means	15.27	9.46	2.12	9.73	9.99	2.26	6.11	9.85	7.17	7.01	7.61	6.76	12.42	9.41	14.53	16.14	15.91	9.27	8.54	4.65	7.91	3.85	12.47	5.17			
Standard Deviations	5.07	3.88	1.43	3.66	4.28	1.52	2.87	3.44	3.14	2.61	2.89	2.68	5.23	2.93	4.52	5.71	5.12	2.66	2.59	1.64	3.07	1.43	3.15	1.92			
Split Half Reliabilities	.623	.590	.322	.618	.690	.375	.490	.546	.597	.491	.523	.504	.748	.503	.652	.663	.744	.481	.494	.287	.614	.234	.538	.473			

Table 37

Obtained Correlations between Tests, Ordered by Degree of Sex Difference

(Results for 757 male seniors above the diagonal and for 681 female seniors below the diagonal)

		Fluid Systems	Mechanical Systems	Electricity	Tools	Stationary Equipment Operation	Connections and Fittings	Measuring Instruments	Layout and Visualization	Vehicular Operation	Structures	Chemicals	Materials	Computing	Medical and First Aid	Dealing with Situations	Clerical	Arithmetic Conventions	Sales	Etiquette	Biological Systems	Foods and Cooking	Operation of Garment Equipment	Service	Style and Grooming	Male		
																										Means	Standard Deviations	Split Half Reliabilities
	Fluid Systems		.644	.590	.629	.509	.588	.557	.424	.544	.488	.501	.504	.305	.291	.353	.071	.238	.178	.091	.094	.176	-.004	.073	-.043	3.41	1.71	.489
	Mechanical Systems	.619		.750	.815	.548	.668	.732	.584	.683	.601	.551	.590	.383	.273	.385	.015	.229	.143	.032	.077	.132	-.117	.047	-.162	14 14	5.20	.731
	Electricity	.559	.753		.727	.500	.682	.700	.605	.617	.630	.604	.631	.484	.375	.402	.159	.351	.270	.134	.167	.218	-.011	.170	-.087	13.90	5.57	.791
	Tools	.598	.786	.705		.548	.683	.744	.565	.679	.568	.494	.577	.361	.210	.358	-.050	.156	.082	.006	.010	.100	-.183	.006	-.216	23.27	8.35	.853
	Stationary Equipment Operation	.487	.613	.548	.576		.532	.418	.355	.457	.400	.412	.384	.232	.181	.244	.021	.177	.100	.002	.078	.115	.032	.043	.015	3.60	1.68	.417
	Connections and Fittings	.567	.690	.707	.712	.564		.642	.583	.636	.588	.510	.575	.434	.310	.353	.125	.269	.194	.114	.116	.175	-.014	.143	-.043	8.44	3.42	.654
	Measuring Instruments	.547	.725	.693	.742	.476	.630		.672	.665	.591	.512	.622	.559	.351	.427	.122	.267	.202	.149	.095	.166	-.145	.156	-.149	13.61	4.48	.733
	Layout and Visualization	.428	.618	.640	.592	.420	.584	.672		.588	.502	.498	.618	.615	.427	.429	.245	.398	.342	.285	.199	.254	.001	.272	.008	9.02	3.66	.690
	Vehicular Operation	.488	.698	.655	.665	.461	.615	.672	.586		.601	.488	.559	.477	.370	.474	.161	.317	.244	.163	.125	.210	-.055	.190	-.027	13.06	3.88	.605
	Structures	.422	.579	.613	.561	.412	.575	.609	.632	.571		.516	.583	.464	.397	.393	.228	.376	.347	.208	.209	.249	.075	.224	.035	9.24	2.87	.569
	Chemicals	.469	.529	.593	.482	.485	.533	.548	.506	.476	.467		.607	.429	.511	.375	.318	.443	.406	.282	.294	.354	.199	.279	.159	7.93	2.87	.570
	Materials	.475	.592	.592	.560	.435	.520	.609	.577	.560	.564	.569		.519	.539	.504	.311	.423	.449	.323	.278	.404	.133	.362	.148	9.04	3.24	.579
	Computing	.273	.363	.446	.327	.227	.347	.526	.594	.413	.434	.454	.500		.496	.508	.467	.535	.469	.349	.238	.334	.098	.418	.115	14.00	5.52	.786
	Medical and First Aid	.227	.250	.307	.195	.219	.237	.315	.389	.285	.394	.454	.500	.479		.516	.547	.608	.627	.488	.472	.539	.430	.557	.445	15.25	4.76	.708
	Dealing with Situations	.152	.207	.246	.195	.121	.208	.295	.303	.343	.378	.327	.380	.369	.468		.356	.451	.474	.418	.197	.407	.173	.405	.188	9.94	2.98	.499
	Clerical	-.020	-.048	.047	-.104	.014	.000	.040	.170	.078	.193	.218	.236	.429	.501	.397		.616	.627	.434	.413	.471	.455	.532	.489	7.50	3.00	.575
	Arithmetic Conventions	.112	.134	.234	.041	.119	.153	.185	.276	.249	.321	.328	.347	.473	.488	.405	.611		.693	.428	.422	.479	.411	.528	.396	16.75	5.40	.655
	Sales	.066	.066	.165	-.005	.037	.071	.158	.244	.203	.281	.318	.375	.488	.573	.511	.636	.662		.515	.442	.486	.424	.590	.432	16.15	5.06	.728
	Etiquette	-.088	-.042	.013	-.057	-.002	.018	.043	.142	.063	.186	.163	.227	.287	.382	.427	.450	.409	.497		.336	.437	.368	.470	.415	4.25	1.70	.442
	Biological Systems	.022	.051	.085	-.023	.012	.033	.089	.174	.065	.189	.226	.239	.223	.477	.286	.375	.335	.403	.280		.426	.432	.364	.430	4.08	1.45	.256
	Foods and Cooking	.092	.058	.107	-.014	.054	.094	.101	.164	.106	.207	.290	.328	.336	.519	.423	.516	.464	.541	.439	.412		.457	.464	.463	8.78	2.62	.458
	Operation of Garment Equipment	-.082	-.132	-.071	-.246	-.031	-.064	-.112	.066	-.097	.094	.122	.100	.194	.437	.228	.479	.399	.446	.326	.423	.440		.416	.709	3.82	2.14	.615
	Service	.004	.015	.082	-.090	.036	.011	.059	.196	.139	.185	.249	.279	.347	.542	.449	.588	.537	.631	.476	.408	.539	.458		.444	7.87	2.48	.434
	Style and Grooming	-.116	-.171	-.101	-.282	-.052	-.112	-.153	.023	-.107	.067	.131	.093	.192	.438	.324	.560	.436	.507	.432	.460	.511	.687	.542		9.55	3.75	.670
Female	Means	2.67	11.36	11.01	18.74	2.96	6.97	11.61	7.79	11.52	8.19	7.14	8.13	13.57	15.06	9.86	7.52	16.92	16.53	4.36	4.22	8.78	3.82	7.87	9.55			
	Standard Deviations	1.59	5.19	5.28	7.66	1.58	3.14	4.52	3.77	4.08	2.81	2.63	3.08	5.65	4.47	2.94	3.08	5.53	5.08	1.61	1.47	2.88	2.15	2.68	3.74			
	Split Half Reliabilities	.435	.775	.789	.825	.405	.570	.754	.732	.642	.583	.486	.574	.772	.668	.485	.607	.632	.758	.217	.151	.540	.589	.524	.642			

Table 38

Proportions of Variance in Common (r^2) between Tests (Corrected for Attenuation) Ordered by Degree of Sex Difference

(results for 757 male seniors above the diagonal and 681 female seniors below the diagonal)

		Fluid Systems	Mechanical Systems	Electricity	Tools	Stationary Equipment Operation	Connections and Fittings	Measuring Instruments	Layout and Visualization	Vehicular Operation	Structures	Chemicals	Materials	Computing	Medical and First Aid	Dealing with Situations	Clerical	Arithmetic Conventions	Sales	Etiquette	Biological Systems	Foods and Cooking	Operation of Garment Equipment	Service	Style and Grooming	Male Means	Male Standard Deviations	Male Split Half Reliabilities
	Fluid Systems		1.000	.899	.950	1.000	1.000	.866	.534	1.000	.856	.900	.898	.247	.246	.512	.018	.178	.090	.037	.072	.138	-.000	.024	-.006	3.09	1.71	.489
	Mechanical Systems	1.000		.971	1.000	.984	.931	.998	.675	1.000	.866	.729	.821	.256	.145	.405	.000	.109	.038	.003	.032	.051	-.031	.006	-.053	13.82	5.20	.732
	Electricity	.910	.928		.784	.758	.899	.845	.670	.795	.882	.809	.869	.376	.252	.410	.055	.237	.127	.051	.139	.133	-.000	.085	-.015	13.90	5.57	.791
	Tools	.997	.967	.763		.843	.835	.886	.542	.893	.666	.502	.674	.194	.073	.300	-.004	.043	.011	.000	.000	.026	-.063	.000	-.082	22.57	8.35	.853
	Stationary Equipment Operation	1.000	1.000	.938	.994		1.000	.572	.438	.829	.675	.714	.610	.165	.112	.288	.000	.114	.033	.000	.056	.068	.004	.011	.000	2.89	1.68	.417
	Connections and Fittings	1.000	1.000	1.000	1.000	1.000		.860	.754	1.000	.930	.697	.873	.366	.207	.383	.043	.168	.080	.045	.078	.103	-.000	.070	-.005	7.90	3.42	.654
	Measuring Instruments	.912	.901	.807	.886	.744	.923		.893	.998	.837	.627	.913	.542	.237	.497	.036	.148	.077	.068	.048	.083	-.047	.075	-.045	13.61	4.48	.733
	Layout and Visualization	.575	.674	.709	.579	.595	.818	.819		.830	.921	.631	.955	.697	.372	.535	.151	.350	.233	.266	.226	.206	.000	.247	.000	9.02	3.66	.690
	Vehicular Operation	.853	.978	.846	.834	.819	1.000	.934	.730		1.000	.690	.891	.479	.320	.745	.075	.253	.136	.101	.103	.159	-.008	.137	-.002	13.06	3.88	.605
	Structures	.701	.741	.817	.655	.720	.997	.843	.934	.872		.821	1.000	.481	.392	.542	.159	.378	.290	.171	.301	.238	.017	.202	.003	8.45	2.87	.569
	Chemicals	1.000	.743	.919	.579	1.000	1.000	.820	.719	.728	.770		1.000	.411	.646	.496	.308	.525	.398	.317	.589	.479	.114	.316	.065	7.81	2.87	.570
	Materials	.904	.787	.773	.662	.815	.826	.857	.793	.851	.949	1.000		.591	.710	.879	.291	.472	.479	.406	.520	.615	.051	.522	.057	9.04	3.24	.579
	Computing	.223	.221	.327	.167	.166	.273	.476	.625	.345	.418	.549	.564		.442	.658	.482	.555	.385	.352	.284	.311	.021	.513	.025	13.94	5.52	.786
	Medical and First Aid	.182	.124	.181	.070	.180	.149	.200	.313	.192	.404	.644	.661	.451		.754	.735	.797	.763	.760	1.000	.898	.425	1.000	.418	14.43	4.76	.708
	Dealing with Situations	.109	.114	.159	.095	.077	.156	.238	.259	.379	.505	.453	.518	.364	.687		.443	.621	.620	.792	.305	.725	.098	.756	.105	9.94	2.98	.499
	Clerical	-.000	-.004	.004	-.022	.000	.000	.004	.065	.015	.105	.163	.161	.392	.629	.537		1.000	.938	.740	1.000	.844	.585	1.000	.621	7.50	3.00	.575
	Arithmetic Conventions	.047	.037	.110	.004	.055	.064	.071	.164	.153	.280	.352	.331	.459	.572	.534	.971		1.000	.631	1.000	.763	.419	.982	.358	16.75	5.40	.655
	Sales	.012	.007	.045	-.000	.003	.012	.044	.108	.084	.179	.274	.324	.407	.657	.709	.878	.914		.823	1.000	.709	.402	1.000	.383	15.67	5.06	.728
	Etiquette	.000	-.012	.000	-.017	-.000	.000	.012	.126	.029	.276	.257	.416	.488	1.000	1.000	1.000	1.000	1.000		1.000	.946	.496	1.000	.581	4.25	1.70	.442
	Biological Systems	.000	.026	.059	-.008	.000	.012	.070	.270	.041	.409	.699	.655	.427	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	1.000	1.000	3.45	1.45	.256
	Foods and Cooking	.030	.007	.026	-.000	.014	.029	.025	.068	.032	.137	.321	.348	.271	.758	.683	.811	.630	.716	1.000	1.000		.741	1.000	.697	8.78	2.62	.458
	Operation of Garment Equipment	-.027	-.037	-.011	-.126	-.004	-.012	-.029	.009	-.024	.026	.052	.030	.084	.492	.182	.640	.427	.446	.828	1.000	.610		.648	1.000	3.74	2.14	.615
	Service	.000	.000	.017	-.019	.005	.000	.008	.099	.057	.111	.243	.259	.296	.852	.795	1.000	.870	1.000	1.000	1.000	1.000	.680		.677	7.87	2.48	.434
	Style and Grooming	-.047	-.058	-.020	-.151	-.012	-.036	-.048	.002	-.027	.011	.054	.024	.075	.455	.338	.805	.468	.528	1.000	1.000	.752	1.000	.875		9.55	3.75	.670
Female	Means	2.40	10.96	11.02	18.24	2.38	6.58	11.62	7.79	11.52	7.51	7.02	8.13	13.52	14.27	9.86	7.52	16.92	16.02	4.36	3.64	9.18	3.90	8.59	10.64			
	Standard Deviations	1.59	5.19	5.28	7.66	1.58	3.14	4.52	3.77	4.08	2.81	2.63	3.08	5.65	4.47	2.94	3.08	5.53	5.08	1.61	1.47	2.88	2.15	2.68	3.74			
	Split Half Reliabilities	.435	.775	.789	.825	.405	.570	.754	.732	.643	.583	.486	.574	.772	.658	.485	.607	.632	.758	.217	.151	.540	.589	.524	.643			

3

Table 39

Observed Minus Expected* Proportions of Variance (Corrected for Attenuation) in Common between Tests, Ordered by Degree of Sex Difference

(results for 757 male seniors above the diagonal and 681 female seniors below the diagonal)

	Fluid Systems	Mechanical Systems	Electricity	Tools	Stationary Equipment Operation	Connections and Fittings	Measuring Instruments	Layout and Visualization	Vehicular Operation	Structures	Chemicals	Materials	Computing	Medical and First Aid	Dealing with Situations	Clerical	Arithmetic Conventions	Sales	Etiquette	Biological Systems	Foods and Cooking	Operation of Garment Equipment	Service	Style and Grooming
Fluid Systems		+.034	-.067	+.028	+.135	+.149	+.106	-.189	+.338	+.208	+.282	+.294	-.121	-.058	+.222	-.235	-.054	-.095	-.148	-.079	+.024	-.087	+.042	+.076
Mechanical Systems	+.036		-.029	+.044	+.085	+.046	+.204	-.082	+.304	+.184	+.077	+.183	-.146	-.192	+.081	-.287	-.157	-.181	-.216	-.153	-.097	-.152	-.010	-.005
Electricity	-.054	-.072		-.172	-.141	+.014	+.051	-.087	+.099	+.200	+.157	+.231	-.026	-.085	+.086	-.232	-.029	-.092	-.168	-.046	-.015	-.121	+.069	+.033
Tools	+.080	+.014	-.190		-.100	-.094	+.048	-.259	+.153	-.060	-.194	-.008	-.252	-.308	-.068	-.335	-.267	-.252	-.263	-.229	-.166	-.228	-.060	-.078
Stationary Equipment Operation	+.144	+.108	+.046	+.055		+.014	-.323	-.420	+.032	-.109	-.039	-.130	-.338	-.327	-.137	-.388	-.254	-.287	-.320	-.231	-.181	-.218	-.107	-.053
Connections and Fittings	+.158	+.122	+.122	+.076	+.014		-.049	-.118	+.189	+.133	-.070	+.120	-.151	-.245	-.056	-.359	-.213	-.254	-.289	-.222	-.160	-.236	-.061	-.072
Measuring Instruments	+.167	+.120	+.026	+.059	-.144	+.020		-.070	+.096	-.051	-.231	+.069	-.066	-.307	-.033	-.457	-.325	-.348	-.357	-.343	-.271	-.374	-.147	-.203
Layout and Visualization	-.130	-.067	-.032	-.209	-.254	-.045	-.141		-.109	-.005	-.264	+.073	+.052	-.209	-.032	-.379	-.160	-.229	-.196	-.203	-.185	-.364	-.013	-.195
Vehicular Operation	+.213	+.302	+.170	+.111	+.035	+.201	+.038	-.205		+.014	-.266	-.052	-.227	-.322	+.117	-.516	-.318	-.387	-.422	-.386	-.293	-.433	-.183	-.258
Structures	+.075	+.079	+.155	-.054	-.050	+.213	-.038	+.013	-.114		-.155	+.044	-.238	-.263	-.100	-.445	-.206	-.247	-.366	-.202	-.228	-.422	-.132	-.267
Chemicals	+.406	+.113	+.289	-.097	+.263	+.248	-.029	-.169	-.225	-.205		+.014	-.339	-.040	-.176	-.327	-.090	-.169	-.250	+.056	-.017	-.355	-.048	-.235
Materials	+.325	+.172	+.158	.000	+.092	+.089	+.022	-.081	-.088	-.004	+.014		-.172	+.011	+.193	-.357	-.156	-.102	-.175	-.027	+.105	-.432	+.144	-.257
Computing	-.104	-.142	-.036	-.243	-.305	-.213	-.107	+.003	-.342	-.283	-.185	-.184		-.494	-.264	-.403	-.310	-.432	-.465	-.500	-.435	-.698	-.102	-.525
Medical and First Aid	-.077	-.171	-.114	-.272	-.223	-.268	-.314	-.241	-.427	-.229	-.021	-.019	-.481		-.178	-.214	-.132	-.119	-.122	+.152	+.087	-.359	+.321	-.197
Dealing with Situations	-.136	-.167	-.122	-.232	-.312	-.247	-.262	-.281	-.225	-.114	-.198	-.147	-.553	-.241		-.520	-.322	-.275	-.103	-.556	-.099	-.699	+.064	-.523
Clerical	-.205	-.245	-.237	-.310	-.349	-.363	-.456	-.435	-.550	-.474	-.449	-.465	-.486	-.317	-.423		+.020	+.006	-.192	+.101	-.017	-.249	+.270	-.044
Arithmetic Conventions	-.137	-.182	-.109	-.262	-.272	-.278	-.368	-.314	-.390	-.278	-.238	-.273	-.397	-.352	-.405	-.007		+.047	-.322	+.081	-.119	-.436	+.232	-.328
Sales	-.121	-.162	-.124	-.216	-.274	-.279	-.345	-.320	-.409	-.328	-.266	-.230	-.399	-.217	-.179	-.050	-.036		-.177	+.034	-.220	-.500	+.203	-.350
Etiquette	-.133	-.181	-.169	-.233	-.277	-.291	-.377	-.302	-.464	-.231	-.283	-.138	-.318	+.126	+.112	+.072	+.050	.000		+.034	+.017	-.406	+.203	-.152
Biological Systems	-.097	-.107	-.074	-.188	-.241	-.243	-.283	-.122	-.416	-.062	+.195	+.137	-.343	+.162	+.147	+.108	+.086	+.036	+.036		+.037	+.064	+.169	+.233
Foods and Cooking	-.028	-.087	-.068	-.140	-.187	-.187	-.288	-.285	-.385	-.295	-.143	-.130	-.459	-.041	-.130	-.042	-.244	-.208	+.076	+.040		-.232	+.132	-.107
Operation of Garment Equipment	-.056	-.102	-.076	-.238	-.177	-.199	-.313	-.315	-.413	-.377	-.383	-.420	-.617	-.278	-.602	-.184	-.418	-.450	-.068	+.068	-.361		-.247	+.169
Service	+.083	+.047	+.064	-.019	-.056	-.076	-.165	-.113	-.220	-.180	-.081	-.079	-.294	+.194	+.122	+.288	+.136	+.216	+.216	+.180	+.140	-.208		-.259
Style and Grooming	+.104	+.057	+.095	-.083	-.005	-.043	-.152	-.142	-.236	-.212	-.201	-.246	-.447	-.135	-.266	+.161	-.197	-.188	+.284	+.248	-.039	+.180	-.057	

$$^{*}E = r^2_{(a)\ max} - \left(r^2_{(a)\ max} - r^2_{(a)\ min}\right)\left(\frac{D_{ij} - D_{min}}{R_d}\right)$$

where E_{ij} is the proportion of variance expected to be in common between variables i and j, based on the distance between them on a reference continuum,

$r^2_{(a)\ max}$ is the maximum proportion of variance in common between any two variables, corrected for attenuation,

$r^2_{(a)\ min}$ is the minimum proportion of variance in common between any two variables, corrected for attenuation,

D_{ij} is the distance between i and j on the reference continuum,

D_{min} is the minimum distance between any two variables, and

R_d is the maximum distance between any two variables minus the minimum distance between any two variables.

Table 40

Correlations between Aptitude and General Vocational Capability Test Scores

(757 male and 681 female high school seniors)

Vocational Capability Test	Males (aptitude) Linguistic	Males (aptitude) Quantitative	Females (aptitude) Linguistic	Females (aptitude) Quantitative
Tools	.140	.178	.175	.190
Mechanical Systems	.204	.246	.219	.221
Measuring Instruments	.324	.404	.325	.377
Stationary Equipment Operation	.089	.127	.112	.068
Vehicular Operation	.299	.349	.282	.302
Connections and Fittings	.199	.268	.156	.135
Fluid Systems	.205	.228	.144	.125
Electricity	.273	.305	.259	.251
Layout and Visualization	.412	.464	.374	.394
Structures	.292	.331	.330	.311
Materials	.450	.389	.435	.352
Chemicals	.384	.299	.360	.264
Foods and Cooking	.364	.231	.384	.255
Biological Systems	.262	.133	.262	.150
Medical and First Aid	.475	.340	.451	.293
Arithmetic Conventions	.456	.369	.404	.355
Clerical	.427	.328	.420	.350
Sales	.486	.370	.501	.392
Dealing with Situations	.408	.402	.382	.312
Service	.358	.288	.391	.283
Etiquette	.367	.269	.363	.296
Style and Grooming	.190	.056	.215	.131
Computing	.552	.639	.520	.576
Garment Equipment Operation	.161	.012	.186	.082

Table 41

Relationships of Linguistic Aptitude Test with School Courses
(High School Seniors)

Test mean based on all 757 males is 27.95 Test mean based on all 681 females is 27.60

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	28.25	678	.046	671	.354	617	.105	27.88	655	-.154	646	.226	589	-.036
Business and Commercial	27.32	317	-.063	310	.178	276	-.182	26.68	530	-.184	513	.272	492	-.018
Chemistry	30.58	470	.099	463	.232	426	.071	29.56	286	.037	281	.205	256	-.120
Drafting	26.75	414	-.167	399	.178	382	-.118	Insufficient cases for analysis						
English	27.95	750	.187	739	.377	661	.116	27.62	680	.064	674	.402	614	.039
Electricity	27.63	103	.100	99	.342	91	-.285	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							24.55	90	-.182	87	.072	83	-.111
Foreign Languages	30.60	447	.330	440	.379	407	.227	29.30	410	.375	405	.356	367	.184
General Science	28.32	599	-.138	584	.396	526	.065	27.71	510	-.106	469	.325	427	.045
Health	26.58	220	-.202	213	-.027	186	-.109	27.28	222	-.172	215	.029	180	-.041
Home Economics	Insufficient cases for analysis							26.42	427	-.091	413	.269	389	-.040
Mathematics	28.53	679	.246	670	.200	623	-.025	28.21	508	.311	498	.289	456	.053
Music	28.06	341	.162	320	.156	305	.040	27.75	439	.126	420	.215	406	-.021
Metals and Machines	25.78	109	-.270	104	.126	98	-.217	Insufficient cases for analysis						
Painting and Drawing	27.41	207	-.011	201	.080	182	-.107	27.61	289	-.006	274	.117	262	.014
Physics	31.43	300	-.025	296	.232	266	-.139	30.15	62	-.028	61	-.027	51	-.214
Sales and Marketing	24.85	72	.211	71	.041	65	-.077	23.97	115	.060	111	.205	108	-.035
Social Studies	28.06	725	.099	705	.381	649	-.001	27.68	665	.141	648	.342	582	.096
Woodworking	26.03	409	-.206	394	.069	378	-.118	Insufficient cases for analysis						

Table 42

Relationships of Quantitative Aptitude Test with School Courses
(High School Seniors)

Test mean based on all 757 males is 20.16 — Test mean based on all 681 females is 20.22

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	20.36	678	.087	671	.312	617	.092	20.36	655	-.091	646	.162	589	-.068
Business and Commercial	19.77	317	-.076	310	.129	276	-.160	19.52	530	-.143	513	.261	492	.002
Chemistry	22.12	470	.160	463	.300	426	.090	21.81	286	-.021	281	.164	256	-.093
Drafting	19.94	414	-.135	399	.216	382	.008	Insufficient cases for analysis						
English	20.16	750	.225	739	.287	661	.000	20.27	680	.127	674	.303	614	-.051
Electricity	20.46	103	.130	99	.374	91	-.161	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							17.39	90	-.108	87	.027	83	.055
Foreign Languages	22.01	447	.338	440	.326	407	.169	21.52	410	.339	405	.310	367	.124
General Science	20.50	599	-.072	584	.389	526	.044	20.34	510	-.134	469	.253	427	.012
Health	19.37	220	-.133	213	-.106	186	-.056	19.93	222	-.103	215	.080	180	-.051
Home Economics	Insufficient cases for analysis							18.95	427	-.129	413	.252	389	-.030
Mathematics	20.65	679	.369	670	.261	623	.143	20.85	508	.420	498	.398	456	.197
Music	19.91	341	.148	320	.070	305	.002	20.13	439	.158	420	.223	406	-.064
Metals and Machines	18.65	109	-.204	104	.065	98	-.220	Insufficient cases for analysis						
Painting and Drawing	19.29	207	.012	201	.040	182	-.054	19.98	289	-.106	274	.116	262	-.043
Physics	23.46	300	.063	296	.245	266	-.087	22.83	62	-.073	61	.133	51	-.106
Sales and Marketing	18.64	72	-.046	71	.191	65	-.076	17.42	115	.031	111	.082	108	-.116
Social Studies	20.26	725	.205	705	.319	649	-.022	20.32	665	.237	648	.287	582	.101
Woodworking	19.49	409	-.230	394	.060	378	-.067	Insufficient cases for analysis						

Table 43

Relationships of Tools with School Courses
(High School Seniors)

Test mean based on all 757 males is 23.27

Test mean based on all 681 females is 18.74

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	22.90	678	.087	671	.038	617	.164	18.56	655	-.045	646	.015	589	.038
Business and Commercial	21.11	317	-.187	310	-.110	276	-.166	16.70	530	-.219	513	-.011	492	-.000
Chemistry	23.98	470	.166	463	.079	426	.274	20.30	286	-.008	281	.109	256	.233
Drafting	28.12	414	.232	399	.223	382	.231	Insufficient cases for analysis						
English	23.28	750	.016	739	-.126	661	-.269	18.70	680	.048	674	-.036	614	-.276
Electricity	30.12	103	.257	99	.249	91	.086	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							14.45	90	.012	87	-.027	83	-.173
Foreign Languages	23.11	447	-.054	440	-.185	407	-.136	18.81	410	.093	405	-.173	367	-.152
General Science	23.68	599	.027	584	.085	526	.242	19.11	510	-.010	469	.107	427	.133
Health	24.36	220	.279	213	-.033	186	-.143	18.51	222	.232	215	.091	180	.037
Home Economics	Insufficient cases for analysis							14.63	427	.112	413	.128	389	-.025
Mathematics	23.61	679	.227	670	-.047	623	.080	19.39	508	.198	498	-.024	456	.048
Music	22.59	341	.016	320	-.218	305	-.201	17.39	439	.025	420	-.046	406	-.074
Metals and Machines	28.10	109	-.024	104	.075	98	.109	Insufficient cases for analysis						
Painting and Drawing	22.77	207	-.014	201	-.064	182	.168	17.75	289	-.005	274	.001	262	-.014
Physics	27.20	300	.066	296	.101	266	.118	24.17	62	-.028	61	.171	51	.207
Sales and Marketing	19.67	72	.076	71	.217	65	.248	17.01	115	.014	111	-.089	108	-.196
Social Studies	23.24	725	-.009	705	-.060	649	-.047	18.68	665	.056	648	.014	582	.029
Woodworking	27.52	409	.040	394	.126	378	.069	Insufficient cases for analysis						

Table 44

Relationships of Mechanical Systems with School Courses
(High School Seniors)

Test mean based on all 757 males is 14.34 Test mean based on all 681 females is 11.36

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	14.22	678	.064	671	.072	617	.179	11.32	655	-.010	646	.039	589	.073
Business and Commercial	13.28	317	-.168	310	-.069	276	-.117	10.13	530	-.127	513	-.006	492	.028
Chemistry	14.88	470	.145	463	.065	426	.279	12.42	286	-.051	281	.103	256	.185
Drafting	16.79	414	.071	399	.229	382	.196	Insufficient cases for analysis						
English	14.35	750	.029	739	-.079	661	-.239	11.36	680	.097	674	.004	614	-.219
Electricity	17.74	103	.201	99	.252	91	.090	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							8.53	90	.151	87	-.019	83	-.018
Foreign Languages	14.36	447	-.019	440	-.128	407	-.114	11.59	410	.131	405	-.125	367	-.066
General Science	14.58	599	-.003	584	.086	526	.187	11.53	510	-.060	469	.149	427	.118
Health	14.02	220	.256	213	.053	186	-.071	11.21	222	.185	215	.058	180	.013
Home Economics	Insufficient cases for analysis							9.25	427	.036	413	.114	389	-.038
Mathematics	14.56	679	.200	670	-.022	623	.072	11.70	508	.228	498	.008	456	.064
Music	13.88	341	.034	320	-.187	305	-.191	10.71	439	.060	420	-.018	406	-.016
Metals and Machines	16.28	109	-.062	104	.071	98	.065	Insufficient cases for analysis						
Painting and Drawing	13.97	207	.032	201	-.056	182	.163	10.46	289	.019	274	.010	262	-.058
Physics	16.91	300	.105	296	.079	266	.149	15.09	62	-.041	61	.092	51	.188
Sales and Marketing	12.21	72	-.076	71	.168	65	.211	9.59	115	.106	111	-.053	108	-.168
Social Studies	14.36	725	.017	705	-.037	649	-.027	11.35	665	.090	648	.060	582	.029
Woodworking	16.40	409	-.003	394	.121	378	.034	Insufficient cases for analysis						

Table 45

Relationships of Measuring Instruments with School Courses (High School Seniors)

Test mean based on all 757 males is 13.61

Test mean based on all 681 females is 11.62

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	13.59	678	.063	671	.195	617	.174	11.63	655	-.024	646	.134	589	.071
Business and Commercial	12.46	317	-.229	310	-.077	276	-.193	10.40	530	-.255	513	.096	492	-.003
Chemistry	14.88	470	.197	463	.203	426	.314	13.13	286	.038	281	.196	256	.153
Drafting	15.43	414	.035	399	.334	382	.181	Insufficient cases for analysis						
English	13.62	750	.084	739	-.002	661	-.216	11.61	680	.093	674	.098	614	-.228
Electricity	16.17	103	.194	99	.395	91	.100	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							8.88	90	-.081	87	.034	83	-.109
Foreign Languages	14.33	447	.124	440	.024	407	-.052	12.11	410	.339	405	.042	367	-.009
General Science	13.81	599	-.022	584	.237	526	.250	11.76	510	-.129	469	.224	427	.134
Health	13.38	220	.113	213	-.074	186	-.102	11.38	222	.177	215	.177	180	-.036
Home Economics	Insufficient cases for analysis							9.56	427	.014	413	.206	389	-.100
Mathematics	13.89	679	.359	670	.122	623	.137	12.16	508	.371	498	.178	456	.165
Music	13.23	341	.110	320	-.051	305	-.124	11.08	439	.034	420	.068	406	-.040
Metals and Machines	14.83	109	-.172	104	.167	98	.112	Insufficient cases for analysis						
Painting and Drawing	13.11	207	.031	201	.045	182	.092	11.02	289	.027	274	.076	262	-.026
Physics	16.86	300	.167	296	.238	266	.096	15.60	62	.010	61	.212	51	.139
Sales and Marketing	11.44	72	.165	71	.367	65	.315	9.51	115	.028	111	.019	108	-.127
Social Studies	13.60	725	.077	705	.112	649	-.035	11.59	665	.143	648	.164	582	.085
Woodworking	14.88	409	-.056	394	.168	378	.047	Insufficient cases for analysis						

Table 46

Relationships of Stationary Equipment Operation with School Courses
(High School Seniors)

Test mean based on all 757 males is 3.60

Test mean based on all 681 females is 2.96

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	3.53	678	.014	671	.006	617	.101	2.92	655	.020	646	.001	589	.015
Business and Commercial	3.42	317	-.117	310	-.039	276	-.089	2.79	530	-.005	513	-.047	492	.097
Chemistry	3.48	470	.102	463	.039	426	.147	3.03	286	-.018	281	.077	256	.086
Drafting	4.02	414	.191	399	.157	382	.115	Insufficient cases for analysis						
English	3.60	750	-.025	739	-.054	661	-.100	2.96	680	.054	674	-.059	614	-.216
Electricity	4.49	103	.136	99	.160	91	.097	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							2.72	90	.016	87	-.210	83	-.042
Foreign Languages	3.49	447	-.095	440	-.149	407	-.104	2.89	410	.030	405	-.098	367	-.110
General Science	3.67	599	.018	584	.013	526	.126	3.00	510	.027	469	.022	427	.058
Health	3.76	220	.112	213	.020	186	-.144	2.97	222	.133	215	.000	180	.012
Home Economics	Insufficient cases for analysis							2.66	427	.074	413	.061	389	.034
Mathematics	3.62	679	.026	670	-.053	623	.005	2.99	508	.077	498	-.049	456	.004
Music	3.58	341	-.019	320	-.149	305	-.138	2.86	439	.035	420	-.023	406	-.007
Metals and Machines	4.13	109	.020	104	.176	98	.252	Insufficient cases for analysis						
Painting and Drawing	3.53	207	-.052	201	-.116	182	.129	2.81	289	-.034	274	-.124	262	-.114
Physics	3.91	300	.117	296	.121	266	.096	3.54	62	.002	61	.014	51	.032
Sales and Marketing	3.28	72	-.059	71	.165	65	.022	2.93	115	.025	111	-.111	108	-.137
Social Studies	3.61	725	-.007	705	-.047	649	-.056	2.96	665	-.001	648	.004	582	-.062
Woodworking	4.00	409	.058	394	.086	378	.033	Insufficient cases for analysis						

Table 47

Relationships of Vehicular Operation with School Courses
(High School Seniors)

Test mean based on all 757 males is 13.06 Test mean based on all 681 females is 11.52

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	13.06	678	.070	671	.139	617	.154	11.50	655	-.093	646	.071	589	.036
Business and Commercial	12.37	317	-.151	310	.019	276	-.148	10.72	530	-.164	513	.097	492	.085
Chemistry	13.85	470	.124	463	.053	426	.175	12.49	286	-.063	281	.099	256	.057
Drafting	14.13	414	-.026	399	.311	382	.186	Insufficient cases for analysis						
English	13.07	750	.073	739	-.016	661	-.150	11.53	680	.072	674	.041	614	-.169
Electricity	14.42	103	.078	99	.294	91	-.080	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							9.61	90	-.062	87	-.075	83	-.046
Foreign Languages	13.57	447	.076	440	-.055	407	-.102	11.87	410	.218	405	-.057	367	-.086
General Science	13.32	599	-.054	584	.178	526	.210	11.68	510	-.143	469	.197	427	.103
Health	12.79	220	.064	213	-.084	186	-.033	11.19	222	.125	215	.030	180	-.020
Home Economics	Insufficient cases for analysis							9.97	427	-.085	413	.128	389	.028
Mathematics	13.32	679	.247	670	.011	623	.051	11.86	508	.272	498	.069	456	.093
Music	12.73	341	.131	320	-.018	305	-.091	10.90	439	.060	420	.026	406	-.022
Metals and Machines	13.06	109	-.019	104	.220	98	.010	Insufficient cases for analysis						
Painting and Drawing	12.62	207	.057	201	.069	182	.113	10.86	289	-.024	274	.051	262	-.040
Physics	15.15	300	-.013	296	.116	266	.087	14.34	62	-.043	61	.091	51	.126
Sales and Marketing	11.18	72	.005	71	.279	65	.253	10.09	115	.077	111	.020	108	-.031
Social Studies	13.09	725	.052	705	.061	649	-.011	11.52	665	.082	648	.124	582	.060
Woodworking	14.02	409	-.040	394	.147	378	.093	Insufficient cases for analysis						

Table 48

Relationships of Connections and Fittings with School Courses (High School Seniors)

Test mean based on all 757 males is 8.44 Test mean based on all 681 females is 6.98

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	8.38	678	.087	671	.097	617	.137	6.90	655	-.002	646	.059	589	.013
Business and Commercial	7.76	317	-.081	310	.017	276	-.094	6.37	530	-.081	513	-.052	492	-.038
Chemistry	8.74	470	.084	463	.063	426	.204	7.45	286	-.010	281	.076	256	.138
Drafting	9.49	414	.087	399	.194	382	.148	Insufficient cases for analysis						
English	8.45	750	.052	739	-.005	661	-.139	6.97	680	.042	674	.012	614	-.175
Electricity	10.05	103	.200	99	.209	91	-.035	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							6.11	90	-.032	87	-.064	83	-.158
Foreign Languages	8.68	447	-.014	440	-.062	407	-.124	6.94	410	.100	405	-.136	367	-.102
General Science	8.51	599	-.023	584	.123	526	.165	7.09	510	.032	469	.092	427	.034
Health	8.32	220	.123	213	-.024	186	-.164	6.93	222	.100	215	.055	180	.025
Home Economics	Insufficient cases for analysis							6.03	427	.078	413	.160	389	.011
Mathematics	8.56	679	.200	670	.019	623	.061	7.13	508	.174	498	.017	456	.042
Music	8.24	341	.017	320	-.127	305	-.174	6.60	439	.087	420	.051	406	.006
Metals and Machines	9.43	109	-.159	104	.180	98	.015	Insufficient cases for analysis						
Painting and Drawing	8.15	207	-.016	201	-.056	182	.099	6.75	289	.040	274	.051	262	.004
Physics	9.91	300	-.042	296	.166	266	.067	8.81	62	.020	61	.092	51	.162
Sales and Marketing	6.92	72	.232	71	.148	65	.207	6.18	115	.051	111	-.034	108	-.130
Social Studies	8.45	725	.062	705	.024	649	-.063	6.98	665	.058	648	.012	582	-.025
Woodworking	9.29	409	-.003	394	.030	378	.032	Insufficient cases for analysis						

Table 49

Relationships of Fluid Systems with School Courses
(High School Seniors)

Test mean based on all 757 males is 3.41   Test mean based on all 681 females is 2.67

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	3.38	678	.028	671	.064	617	.114	2.65	655	-.020	646	.042	589	.033
Business and Commercial	3.15	317	-.107	310	-.046	276	-.123	2.40	530	-.106	513	.077	492	.024
Chemistry	3.58	470	.138	463	.013	426	.166	2.91	286	-.037	281	.058	256	.150
Drafting	3.95	414	.015	399	.159	382	.118	Insufficient cases for analysis						
English	3.41	750	-.009	739	-.045	661	-.163	2.67	680	.069	674	.018	614	-.115
Electricity	4.21	103	.249	99	.272	91	.024	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							1.94	90	-.155	87	.027	83	-.073
Foreign Languages	3.44	447	-.032	440	-.120	407	-.097	2.67	410	.151	405	-.068	367	-.055
General Science	3.44	599	-.022	584	.056	526	.233	2.68	510	-.015	469	.101	427	.096
Health	3.33	220	.098	213	-.017	186	-.113	2.69	222	.123	215	.116	180	.046
Home Economics	Insufficient cases for analysis							2.18	427	.067	413	.074	389	-.097
Mathematics	3.48	679	.124	670	-.027	623	.041	2.73	508	.155	498	-.007	456	.029
Music	3.31	341	-.003	320	-.176	305	-.179	2.57	439	.050	420	.015	406	.026
Metals and Machines	3.72	109	-.124	104	.115	98	.047	Insufficient cases for analysis						
Painting and Drawing	3.20	207	-.045	201	-.041	182	.140	2.47	289	-.016	274	.000	262	-.045
Physics	4.12	300	.136	296	.098	266	.034	3.51	62	-.080	61	.127	51	.159
Sales and Marketing	2.46	72	.166	71	.082	65	.148	2.47	115	.074	111	-.057	108	-.154
Social Studies	3.42	725	-.014	705	.009	649	-.004	2.68	665	.019	648	.068	582	.022
Woodworking	3.82	409	-.021	394	.048	378	.041	Insufficient cases for analysis						

Table 50

Relationships of Electricity with School Courses
(High School Seniors)

Test mean based on all 757 males is 13.90

Test mean based on all 681 females is 11.02

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	13.84	678	.095	671	.146	617	.153	10.97	655	-.066	646	.138	589	.054
Business and Commercial	12.83	317	-.190	310	-.021	276	-.191	9.79	530	-.134	513	.036	492	.043
Chemistry	14.73	470	.173	463	.199	426	.300	12.23	286	-.025	281	.189	256	.173
Drafting	15.69	414	.068	399	.196	382	.145	Insufficient cases for analysis						
English	13.91	750	.052	739	.043	661	-.178	11.01	680	.064	674	.086	614	-.157
Electricity	18.45	103	.379	99	.286	91	.068	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							8.70	90	.093	87	-.022	83	.004
Foreign Languages	14.24	447	.018	440	-.057	407	-.078	11.39	410	.214	405	-.041	367	-.039
General Science	14.14	599	-.018	584	.188	526	.210	11.22	510	-.049	469	.202	427	.125
Health	13.85	220	.204	213	.001	186	-.133	10.74	222	.079	215	.093	180	-.014
Home Economics	Insufficient cases for analysis							9.14	427	-.029	413	.143	389	-.073
Mathematics	14.19	679	.251	670	.068	623	.084	11.47	508	.226	498	.068	456	.091
Music	13.67	341	.068	320	-.051	305	-.180	10.67	439	.089	420	.039	406	-.018
Metals and Machines	14.58	109	-.238	104	.118	98	-.245	Insufficient cases for analysis						
Painting and Drawing	13.47	207	-.045	201	-.024	182	.080	10.53	289	-.049	274	.021	262	-.032
Physics	17.13	300	.157	296	.262	266	.148	14.92	62	.008	61	.249	51	.170
Sales and Marketing	11.59	72	.057	71	.488	65	.330	8.93	115	-.012	111	-.048	108	-.000
Social Studies	13.91	725	.049	705	.084	649	-.036	11.02	665	.056	648	.136	582	.076
Woodworking	15.08	409	-.126	394	.152	378	.029	Insufficient cases for analysis						

Table 51

Relationships of Layout and Visualization with School Courses
(High School Seniors)

Test mean based on all 757 males is 9.02

Test mean based on all 681 females is 7.79

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	9.10	678	.008	671	.255	617	.153	7.84	655	-.037	646	.174	589	.033
Business and Commercial	8.29	317	-.174	310	.095	276	-.142	6.85	530	-.190	513	.143	492	.024
Chemistry	10.10	470	.099	463	.192	426	.177	8.85	286	-.012	281	.246	256	.044
Drafting	10.14	414	.044	399	.352	382	.221	Insufficient cases for analysis						
English	9.03	750	.129	739	.148	661	-.120	7.80	680	.104	674	.187	614	-.148
Electricity	10.13	103	.119	99	.283	91	-.016	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							6.06	90	-.049	87	-.168	83	-.173
Foreign Languages	9.77	447	.148	440	.157	407	.030	8.25	410	.309	405	.122	367	.070
General Science	9.04	599	-.127	584	.298	526	.172	7.98	510	-.110	469	.250	427	.073
Health	8.45	220	.003	213	-.098	186	-.166	7.54	222	.054	215	.078	180	-.050
Home Economics	Insufficient cases for analysis							6.69	427	-.072	413	.197	389	-.042
Mathematics	9.24	679	.365	670	.229	623	.140	8.15	508	.388	498	.250	456	.167
Music	8.75	341	.155	320	.106	305	-.016	7.54	439	.096	420	.113	406	.014
Metals and Machines	8.28	109	-.002	104	.232	98	-.036	Insufficient cases for analysis						
Painting and Drawing	8.75	207	.101	201	.141	182	.027	7.73	289	.106	274	.186	262	.053
Physics	11.43	300	.017	296	.256	266	.146	10.53	62	-.011	61	.208	51	.062
Sales and Marketing	6.64	72	.176	71	.304	65	.366	5.72	115	.057	111	.036	108	.073
Social Studies	9.04	725	.134	705	.143	649	-.106	7.80	665	.115	648	.230	582	.045
Woodworking	9.29	409	-.205	394	.204	378	.077	Insufficient cases for analysis						

Table 52

Relationships of Structures with School Courses (High School Seniors)

Test mean based on all 757 males is 9.24 Test mean based on all 681 females is 8.20

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	9.26	678	.044	671	.226	617	.183	8.22	655	-.086	646	.155	589	.102
Business and Commercial	8.78	317	-.117	310	.090	276	-.100	7.67	530	-.132	513	.121	492	.064
Chemistry	9.92	470	.171	463	.106	426	.186	8.84	286	-.082	281	.102	256	.074
Drafting	9.77	414	-.003	399	.241	382	.122	Insufficient cases for analysis						
English	9.25	750	.041	739	.136	661	-.082	8.21	680	.094	674	.145	614	-.087
Electricity	10.15	103	.204	99	.348	91	.020	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							6.53	90	-.259	87	-.069	83	-.122
Foreign Languages	9.72	447	.084	440	.042	407	-.038	8.50	410	.303	405	.053	367	.046
General Science	9.34	599	-.075	584	.223	526	.176	8.33	510	-.107	469	.178	427	.058
Health	9.09	220	.052	213	.047	186	-.054	7.84	222	.067	215	.053	180	.028
Home Economics	Insufficient cases for analysis							7.53	427	-.018	413	.124	389	-.090
Mathematics	9.41	679	.268	670	.127	623	.083	8.43	508	.267	498	.106	456	.128
Music	9.08	341	.097	320	-.040	305	-.098	7.92	439	.058	420	.128	406	.115
Metals and Machines	9.17	109	-.060	104	.233	98	-.018	Insufficient cases for analysis						
Painting and Drawing	9.06	207	.021	201	.060	182	.027	8.00	289	.159	274	.101	262	.063
Physics	10.58	300	-.026	296	.161	266	.075	9.92	62	-.028	61	.107	51	.009
Sales and Marketing	7.74	72	.112	71	.090	65	.234	6.90	115	.075	111	.021	108	.010
Social Studies	9.25	725	.068	705	.125	649	.013	8.20	665	.169	648	.209	582	.131
Woodworking	9.60	409	-.074	394	.078	378	.052	Insufficient cases for analysis						

Table 53

Relationships of Materials with School Courses
(High School Seniors)

Test mean based on all 757 males is 9.04 Test mean based on all 681 females is 8.13

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	9.08	678	.042	671	.268	617	.184	8.13	655	-.063	646	.160	589	.082
Business and Commercial	8.51	317	-.154	310	.048	276	-.166	7.46	530	-.163	513	.078	492	.008
Chemistry	9.98	470	.140	463	.136	426	.206	8.87	286	.003	281	.138	256	.135
Drafting	9.33	414	.049	399	.206	382	.065	Insufficient cases for analysis						
English	9.04	750	.092	739	.155	661	-.057	8.13	680	.097	674	.159	614	-.087
Electricity	9.96	103	.150	99	.380	91	-.009	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							7.02	90	.050	87	-.088	83	-.066
Foreign Languages	9.77	447	.053	440	.060	407	-.015	8.46	410	.244	405	.105	367	.034
General Science	9.24	599	-.109	584	.265	526	.211	8.23	510	-.076	469	.199	427	.121
Health	8.68	220	.054	213	-.078	186	-.155	8.05	222	.023	215	.056	180	-.025
Home Economics	Insufficient cases for analysis							7.40	427	.036	413	.091	389	-.141
Mathematics	9.30	679	.231	670	.114	623	.035	8.35	508	.236	498	.095	456	.052
Music	9.00	341	.110	320	.067	305	-.075	7.97	439	.060	420	.055	406	-.018
Metals and Machines	8.65	109	-.205	104	.177	98	-.075	Insufficient cases for analysis						
Painting and Drawing	9.09	207	.056	201	.155	182	.141	7.94	289	.028	274	.212	262	-.011
Physics	10.60	300	.066	296	.232	266	.047	10.06	62	.000	61	.115	51	.072
Sales and Marketing	7.33	72	.000	71	.235	65	.268	6.88	115	.004	111	-.060	108	-.021
Social Studies	9.09	725	.087	705	.170	649	.004	8.15	665	.107	648	.181	582	.047
Woodworking	9.21	409	-.124	394	.112	378	.031	Insufficient cases for analysis						

Table 54

Relationships of Chemicals with School Courses
(High School Seniors)

Test mean based on all 757 males is 7.98

Test mean based on all 681 females is 7.15

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	8.05	678	.040	671	.217	617	.191	7.16	655	.026	646	.168	589	.088
Business and Commercial	7.51	317	-.077	310	.091	276	-.097	6.71	530	-.198	513	.070	492	.020
Chemistry	8.85	470	.074	463	.171	426	.248	7.89	286	-.068	281	.122	256	.104
Drafting	8.06	414	-.064	399	.162	382	-.009	Insufficient cases for analysis						
English	7.98	750	.107	739	.148	661	-.016	7.16	680	.094	674	.176	614	-.062
Electricity	8.88	103	.191	99	.239	91	-.115	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							6.31	90	.063	87	-.092	83	-.164
Foreign Languages	8.61	447	-.023	440	.001	407	-.090	7.43	410	.294	405	.099	367	.007
General Science	8.09	599	-.109	584	.176	526	.203	7.21	510	-114	469	.181	427	.148
Health	7.67	220	-.004	213	-.191	186	-.243	7.06	222	-.090	215	.096	180	-.024
Home Economics	Insufficient cases for analysis							6.59	427	.039	413	.212	389	-.004
Mathematics	8.17	679	.138	670	.056	623	.015	7.36	508	.247	498	.110	456	.071
Music	7.96	341	.088	320	-.001	305	-.083	7.07	439	.091	420	.077	406	.004
Metals and Machines	7.32	109	-.255	104	.056	98	-.140	Insufficient cases for analysis						
Painting and Drawing	7.87	207	-.072	201	.018	182	.025	6.95	289	.050	274	.076	262	.024
Physics	9.28	300	.035	296	.217	266	.105	8.53	62	.011	61	.072	51	-.028
Sales and Marketing	6.69	72	.086	71	.289	65	.238	6.14	115	.080	111	.002	108	.055
Social Studies	8.01	725	.042	705	.164	649	-.002	7.18	665	.113	648	.180	582	.056
Woodworking	7.92	409	-.062	394	.096	378	-.031	Insufficient cases for analysis						

Table 55

Relationships of Foods and Cooking with School Courses
(High School Seniors)

Test mean based on all 757 males is 8.78 Test mean based on all 681 males is 9.18

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	8.84	678	-.012	671	.164	617	.060	9.26	655	-.038	646	.185	589	.092
Business and Commercial	8.85	317	.072	310	.118	276	-.026	9.27	530	-.059	513	.122	492	-.037
Chemistry	9.08	470	.068	463	.068	426	.071	9.40	286	-.051	281	.067	256	-.067
Drafting	8.05	414	.018	399	.104	382	.024	Insufficient cases for analysis						
English	8.78	750	.133	739	.213	661	.161	9.22	680	.059	674	.217	614	.125
Electricity	8.73	103	.260	99	.181	91	-.311	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							9.20	90	-.071	87	.224	83	.088
Foreign Languages	9.29	447	.009	440	.082	407	.082	9.65	410	.182	405	.182	367	.100
General Science	8.81	599	-.139	584	.191	526	.070	9.22	510	-.150	469	.124	427	-.060
Health	8.18	220	-.080	213	-.047	186	-.100	9.09	222	-.150	215	.021	180	.108
Home Economics	Insufficient cases for analysis							9.74	427	.024	413	.168	389	.165
Mathematics	8.87	679	.025	670	.086	623	-.070	9.24	508	.080	498	.138	456	-.018
Music	8.88	341	.082	320	.145	305	.043	9.38	439	.113	420	.174	406	.110
Metals and Machines	7.80	109	-.110	104	.121	98	-.128	Insufficient cases for analysis						
Painting and Drawing	8.94	207	-.045	201	.102	182	-.139	9.38	289	.116	274	.209	262	.031
Physics	9.05	300	.011	296	.130	266	.010	9.43	62	.074	61	-.043	51	.231
Sales and Marketing	7.90	72	-.051	71	-.161	65	.180	8.42	115	-.048	111	.163	108	.225
Social Studies	8.81	725	.126	705	.175	649	-.024	9.23	665	.987	648	.182	582	-.018
Woodworking	7.87	409	-.141	394	-.015	378	.028	Insufficient cases for analysis						

Table 56

Relationships of Biological Systems with School Courses
(High School Seniors)

Test mean based on all 757 males is 4.08 — Test mean based on all 681 females is 4.23

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	4.17	678	.053	671	.171	617	.097	4.28	655	.367	646	.263	589	.122
Business and Commercial	4.27	317	.000	310	.150	276	.015	4.24	530	.011	513	.210	492	.036
Chemistry	4.22	470	-.025	463	.105	426	.056	4.35	286	.002	281	.043	256	-.049
Drafting	3.66	414	-.166	399	.081	382	-.055	Insufficient cases for analysis						
English	4.09	750	.093	739	.174	661	.130	4.24	680	.075	674	.230	614	.172
Electricity	3.72	103	.010	99	.101	91	.076	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							4.14	90	.064	87	.063	83	.111
Foreign Languages	4.23	447	-.010	440	.168	407	.153	4.40	410	.230	405	.246	367	.156
General Science	4.07	599	-.111	584	.166	526	.050	4.25	510	-.122	469	.208	427	.060
Health	3.57	220	-.128	213	-.076	186	.076	4.22	222	-.120	215	.008	180	.066
Home Economics	Insufficient cases for analysis							4.55	427	.055	413	.164	389	.016
Mathematics	4.08	679	-.005	670	.082	623	-.035	4.22	508	.094	498	.125	456	.032
Music	4.16	341	.094	320	.142	305	.061	4.39	439	.027	420	.127	406	.119
Metals and Machines	3.30	109	-.119	104	.146	98	-.129	Insufficient cases for analysis						
Painting and Drawing	4.24	207	-.039	201	.125	182	-.134	4.48	289	.104	274	.191	262	.003
Physics	4.18	300	.054	296	.057	266	-.034	4.27	62	-.026	61	.107	51	-.125
Sales and Marketing	3.59	72	.271	71	.018	65	.290	3.74	115	.120	111	.065	108	.129
Social Studies	4.08	725	.104	705	.143	649	-.040	4.25	665	.089	648	.168	582	-.078
Woodworking	3.62	409	-.059	394	.049	378	.000	Insufficient cases for analysis						

Table 57

Relationships of Medical and First Aid with School Courses
(High School Seniors)

Test mean based on all 757 males is 15.26 — Test mean based on all 681 females is 15.07

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	15.49	678	.056	671	.289	617	.132	15.22	655	-.005	646	.292	589	.144
Business and Commercial	15.24	317	-.040	310	.207	276	-.049	14.73	530	-.143	513	.226	492	.052
Chemistry	16.50	470	.090	463	.154	426	.179	15.95	286	.001	281	.206	256	.022
Drafting	13.88	414	-.107	399	.164	382	-.006	Insufficient cases for analysis						
English	15.26	750	.085	739	.295	661	.126	15.12	680	.121	674	.296	614	.111
Electricity	15.38	103	.173	99	.217	91	-.092	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							14.23	90	-.032	87	.123	83	-.102
Foreign Languages	16.58	447	.077	440	.154	407	.121	15.87	410	.288	405	.244	367	.095
General Science	15.34	599	-.181	584	.269	526	.087	15.18	510	-.137	469	.268	427	.065
Health	14.15	220	-.132	213	-.097	186	-.119	14.69	222	-.140	215	.056	180	.140
Home Economics	Insufficient cases for analysis							15.47	427	.059	413	.193	389	-.020
Mathematics	15.50	679	.119	670	.176	623	.024	15.26	508	.206	498	.204	456	.075
Music	15.51	341	.101	320	.213	305	.107	15.31	439	.097	420	.145	406	.119
Metals and Machines	12.72	109	-.211	104	.075	98	-.149	Insufficient cases for analysis						
Painting and Drawing	15.37	207	-.043	201	.121	182	-.006	15.25	289	.098	274	.211	262	.045
Physics	16.79	300	.061	296	.167	266	-.001	16.32	62	.110	61	.126	51	-.131
Sales and Marketing	13.08	72	.351	71	.236	65	.104	13.13	115	.177	111	.010	108	.062
Social Studies	15.30	725	.091	705	.254	649	.008	15.15	665	.128	648	.270	582	.051
Woodworking	13.66	409	-.123	394	-.028	378	-.074	Insufficient cases for analysis						

Table 58

Relationships of Arithmetic Conventions with School Courses

(High School Seniors)

Test mean based on all 757 males is 16.75 | Test mean based on all 681 females is 16.92

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	16.99	678	.024	671	.272	617	.051	17.06	655	-.076	646	.242	589	.044
Business and Commercial	17.30	317	.199	310	.292	276	.071	17.53	530	.107	513	.371	492	.115
Chemistry	17.51	470	.128	463	.234	426	.197	17.19	286	-.002	281	.187	256	-.008
Drafting	15.14	414	-.149	399	.183	382	.017	Insufficient cases for analysis						
English	16.76	750	.099	739	.360	661	.141	16.96	680	.072	674	.331	614	.184
Electricity	16.42	103	.153	99	.257	91	-.289	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							15.42	90	-.217	87	.224	83	.072
Foreign Languages	17.63	447	.145	440	.227	407	.147	17.69	410	.187	405	.205	367	.116
General Science	16.79	599	-.228	584	.288	526	.039	17.19	510	-.207	469	.199	427	-.061
Health	15.48	220	-.103	213	-.056	186	.115	16.67	222	-.133	215	.024	180	.002
Home Economics	Insufficient cases for analysis							17.60	427	-.101	413	.167	389	.038
Mathematics	16.95	679	.070	670	.223	623	.037	16.98	508	.012	498	.198	456	.100
Music	17.08	341	.050	320	.161	305	-.028	16.90	439	.073	420	.150	406	.054
Metals and Machines	13.84	109	-.222	104	.085	98	-.221	Insufficient cases for analysis						
Painting and Drawing	16.74	207	-.125	201	.087	182	-.117	16.69	289	-.062	274	.127	262	-.016
Physics	18.16	300	-.018	296	.221	266	-.030	17.44	62	.070	61	.086	51	-.133
Sales and Marketing	14.26	72	.134	71	.280	65	.379	15.28	115	.030	111	.257	108	.126
Social Studies	16.83	725	.093	705	.360	649	.042	17.02	665	.134	648	.308	582	.056
Woodworking	15.03	409	-.192	394	-.023	378	-.080	Insufficient cases for analysis						

Table 59

Relationships of Clerical with School Courses
(High School Seniors)

Test mean based on all 757 males is 7.50 — Test mean based on all 681 females is 7.52

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	7.58	678	.023	671	.303	617	.088	7.62	655	-.076	646	.293	589	.075
Business and Commercial	7.71	317	.105	310	.282	276	.041	7.72	530	.068	513	.318	492	.068
Chemistry	7.95	470	.038	463	.189	426	.115	7.71	286	-.009	281	.141	256	-.136
Drafting	6.28	414	-.111	399	.137	382	-.079	Insufficient cases for analysis						
English	7.50	750	.120	739	.394	661	.227	7.54	680	.071	674	.367	614	.223
Electricity	7.21	103	.155	99	.228	91	-.131	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							6.98	90	-.098	87	.112	83	.114
Foreign Languages	8.12	447	.128	440	.329	407	.193	8.03	410	.198	405	.271	367	.148
General Science	7.50	599	-.120	584	.295	526	-.018	7.63	510	-.173	469	.219	427	-.064
Health	6.85	220	-.027	213	.038	186	.077	7.29	222	-.152	215	.036	180	.069
Home Economics	Insufficient cases for analysis							8.15	427	-.135	413	.196	389	.062
Mathematics	7.59	679	.074	670	.216	623	.028	7.63	508	.068	498	.225	456	.010
Music	7.77	341	.125	320	.308	305	.125	7.78	439	.094	420	.254	406	.076
Metals and Machines	6.09	109	.009	104	.268	98	-.053	Insufficient cases for analysis						
Painting and Drawing	7.75	207	-.108	201	.201	182	-.094	7.36	289	.038	274	.175	262	.053
Physics	7.79	300	-.080	296	.159	266	-.067	7.35	62	.113	61	-.085	51	-.241
Sales and Marketing	6.00	72	.071	71	.292	65	.104	6.20	115	.037	111	.161	108	.174
Social Studies	7.54	725	.116	705	.346	649	.043	7.57	665	.160	648	.301	582	.039
Woodworking	6.14	409	-.224	394	-.061	378	-.079	Insufficient cases for analysis						

Table 60

Relationships of Computing with School Courses
(High School Seniors)

Test mean based on all 757 males is 14.00 | Test mean based on all 681 females is 13.57

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	14.13	678	.045	671	.337	617	.166	13.69	655	-.033	646	.251	589	.028
Business and Commercial	13.35	317	-.214	310	.152	276	-.149	12.63	530	-.053	513	.325	492	.011
Chemistry	15.96	470	.130	463	.317	426	.222	15.55	286	.056	281	.287	256	.049
Drafting	14.11	414	-.072	399	.283	382	.010	Insufficient cases for analysis						
English	14.01	750	.166	739	.271	661	-.067	13.58	680	.119	674	.295	614	-.020
Electricity	15.59	103	.224	99	.313	91	-.108	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							11.00	90	.016	87	-.005	83	-.011
Foreign Languages	15.65	447	.274	440	.343	407	.172	14.88	410	.398	405	.315	367	.171
General Science	14.18	599	-.153	584	.383	526	.115	13.70	510	-.123	469	.348	427	.081
Health	13.16	220	-.030	213	-.053	186	.027	13.06	222	-.008	215	.090	180	-.039
Home Economics	Insufficient cases for analysis							12.33	427	-.059	413	.223	389	.016
Mathematics	14.47	679	.385	670	.327	623	.172	14.36	508	.421	498	.441	456	.256
Music	13.84	341	.149	320	.115	305	-.061	13.62	439	.108	420	.192	406	.009
Metals and Machines	13.07	109	-.151	104	.143	98	-.143	Insufficient cases for analysis						
Painting and Drawing	13.23	207	-.054	201	.048	182	-.141	12.98	289	.026	274	.154	262	-.011
Physics	17.78	300	-.006	296	.361	266	-.019	17.43	62	.011	61	.223	51	.005
Sales and Marketing	10.77	72	.058	71	.288	65	.206	10.36	115	.067	111	.102	108	.004
Social Studies	14.07	725	.170	705	.283	649	-.090	13.62	665	.112	648	.348	582	.085
Woodworking	13.56	409	-.198	394	.122	378	-.048	Insufficient cases for analysis						

Table 61

Relationships of Sales with School Courses
(High School Seniors)

Test mean based on all 757 males is 16.15 — Test mean based on all 681 females is 16.53

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	16.34	678	.027	671	.283	617	.058	16.71	655	-.104	646	.227	589	-.007
Business and Commercial	16.41	317	.057	310	.221	276	-.012	16.61	530	-.077	513	.317	492	-.011
Chemistry	17.15	470	.056	463	.156	426	.040	17.22	286	-.032	281	.134	256	-.077
Drafting	14.41	414	-.114	399	.078	382	-.050	Insufficient cases for analysis						
English	16.16	750	.113	739	.367	661	.172	16.57	680	.120	674	.390	614	.186
Electricity	15.29	103	.209	99	.255	91	-.196	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							15.19	90	-.043	87	.278	83	-.008
Foreign Languages	17.28	447	.125	440	.285	407	.139	17.67	410	.306	405	.298	367	.188
General Science	16.23	599	-.186	584	.288	526	-.006	16.72	510	-.193	469	.231	427	-.039
Health	15.20	220	-.105	213	-.084	186	-.067	16.06	222	-.088	215	.056	180	-.005
Home Economics	Insufficient cases for analysis							17.01	427	-.043	413	.214	389	.054
Mathematics	16.37	679	.091	670	.180	623	-.045	16.85	508	.095	498	.174	456	.012
Music	16.54	341	.108	320	.168	305	.019	16.85	439	.052	420	.162	406	.076
Metals and Machines	12.99	109	-.179	104	.238	98	-.157	Insufficient cases for analysis						
Painting and Drawing	16.56	207	-.054	201	.115	182	-.086	16.52	289	.037	274	.166	262	.050
Physics	17.11	300	.016	296	.236	266	-.069	17.24	62	.040	61	.018	51	-.215
Sales and Marketing	13.85	72	.206	71	.258	65	.361	14.84	115	.042	111	.325	108	.088
Social Studies	16.19	725	.141	705	.347	649	.047	16.63	665	.177	648	.370	582	.090
Woodworking	14.36	409	-.161	394	-.095	378	-.168	Insufficient cases for analysis						

Table 62

Relationships of Dealing with Situations with School Courses
(High School Seniors)

Test mean based on all 757 males is 9.94 Test mean based on all 681 females is 9.86

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	9.99	678	.061	671	.162	617	.054	9.92	655	-.101	646	.152	589	-.008
Business and Commercial	9.62	317	-.045	310	.041	276	-.068	9.66	530	-.080	513	.192	492	-.133
Chemistry	10.55	470	.154	463	.136	426	.078	10.27	286	-.043	281	.136	256	.032
Drafting	9.88	414	-.024	399	.198	382	.059	Insufficient cases for analysis						
English	9.94	750	.128	739	.153	661	-.034	9.89	680	.072	674	.203	614	-.028
Electricity	10.42	103	.081	99	.188	91	-.027	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							8.94	90	.028	87	.027	83	-.151
Foreign Languages	10.55	447	.108	440	.117	407	.081	10.22	410	.275	405	.134	367	.068
General Science	10.11	599	-.101	584	.205	526	.122	10.00	510	-.075	469	.201	427	.031
Health	9.72	220	-.078	213	-.108	186	-.056	9.59	222	.017	215	.050	180	-.049
Home Economics	Insufficient cases for analysis							9.84	427	-.040	413	.109	389	.025
Mathematics	10.09	679	.159	670	.096	623	.042	10.01	508	.158	498	.153	456	.049
Music	9.87	341	.119	320	.075	305	-.096	9.74	439	.050	420	.098	406	-.051
Metals and Machines	9.33	109	-.115	104	.011	98	-.139	Insufficient cases for analysis						
Painting and Drawing	9.87	207	-.044	201	.035	182	.025	9.73	289	.045	274	.137	262	-.094
Physics	11.21	300	-.016	296	.121	266	-.129	10.64	62	-.045	61	.065	51	-.059
Sales and Marketing	8.46	72	.089	71	.101	65	.260	9.04	115	.132	111	.132	108	-.012
Social Studies	9.96	725	.137	705	.174	649	-.004	9.91	665	.132	648	.197	582	.052
Woodworking	9.74	409	-.100	394	-.015	378	-.112	Insufficient cases for analysis						

Table 63

Relationships of Service with School Courses
(High School Seniors)

Test mean based on all 757 males is 7.87 Test mean based on all 681 females is 8.59

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	7.93	678	.052	671	.263	617	.088	8.66	655	-.085	646	.198	589	.035
Business and Commercial	7.94	317	.042	310	.216	276	.048	8.68	530	-.035	513	.242	492	-.035
Chemistry	8.31	470	.025	463	.162	426	.020	8.75	286	-.025	281	.086	256	-.126
Drafting	6.99	414	.013	399	.121	382	-.008	Insufficient cases for analysis						
English	7.87	750	.110	739	.288	661	.144	8.62	680	.093	674	.297	614	.169
Electricity	7.78	103	.191	99	.168	91	.041	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							8.06	90	-.094	87	.120	83	.014
Foreign Languages	8.45	447	.102	440	.244	407	.102	9.06	410	.247	405	.199	367	.116
General Science	7.91	599	-.150	584	.288	526	.000	8.66	510	-.195	469	.185	427	-.082
Health	7.39	220	.002	213	.051	186	.089	8.49	222	-.098	215	-.000	180	.004
Home Economics	Insufficient cases for analysis							9.16	427	.006	413	.182	389	.081
Mathematics	7.95	679	.075	670	.183	623	-.034	8.68	508	.082	498	.107	456	-.035
Music	8.07	341	.069	320	.283	305	.091	8.71	439	.073	420	.198	406	.059
Metals and Machines	6.38	109	.048	104	.195	98	-.002	Insufficient cases for analysis						
Painting and Drawing	8.04	207	-.080	201	.171	182	-.091	8.65	289	.142	274	.178	262	.048
Physics	8.11	300	.042	296	.165	266	-.040	8.58	62	.132	61	-.064	51	-.224
Sales and Marketing	6.97	72	.175	71	.166	65	.110	7.50	115	.092	111	.199	108	.170
Social Studies	7.89	725	.152	705	.275	649	.024	8.62	665	.168	648	.263	582	.022
Woodworking	7.05	409	-.134	394	-.042	378	-.165	Insufficient cases for analysis						

Table 64

Relationships of Etiquette with School Courses
(High School Seniors)

Test mean based on all 757 males is 4.25 Test mean based on all 681 females is 4.36

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	4.31	678	.031	671	.177	617	.031	4.40	655	-.027	646	.153	589	.040
Business and Commercial	4.18	317	-.006	310	.203	276	.005	4.35	530	-.060	513	.161	492	-.012
Chemistry	4.58	470	.051	463	.167	426	.100	4.48	286	.015	281	.077	256	-.118
Drafting	3.81	414	.013	399	.137	382	.074	Insufficient cases for analysis						
English	4.25	750	.120	739	.281	661	.189	4.38	680	.072	674	.271	614	.135
Electricity	3.99	103	.205	99	.319	91	.034	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							4.19	90	-.037	87	.003	83	-.038
Foreign Languages	4.67	447	.127	440	.246	407	.153	4.62	410	.231	405	.196	367	.060
General Science	4.24	599	-.164	584	.224	526	-.053	4.43	510	-.121	469	.086	427	-.120
Health	3.91	220	-.026	213	-.157	186	-.055	4.24	222	-.077	215	-.027	180	.025
Home Economics	Insufficient cases for analysis							4.53	427	-.016	413	.137	389	.006
Mathematics	4.32	679	.114	670	.131	623	-.006	4.42	508	.135	498	.128	456	.031
Music	4.41	341	.134	320	.290	305	.039	4.40	439	.093	420	.190	406	.003
Metals and Machines	3.32	109	.002	104	.274	98	.064	Insufficient cases for analysis						
Painting and Drawing	4.42	207	-.093	201	.098	182	-.166	4.36	289	.092	274	.227	262	.067
Physics	4.54	300	.001	296	.110	266	-.106	4.49	62	-.021	61	-.051	51	-.256
Sales and Marketing	3.44	72	.021	71	-.005	65	-.071	3.96	115	-.009	111	.001	108	.037
Social Studies	4.27	725	.134	705	.234	649	.003	4.39	665	.122	648	.215	582	-.008
Woodworking	3.68	409	-.062	394	.090	378	-.037	Insufficient cases for analysis						

Table 65

Relationships of Style and Grooming with School Courses
(High School Seniors)

Test mean based on all 757 males is 9.55

Test mean based on all 681 females is 10.64

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	9.68	678	-.026	671	.150	617	.026	10.77	655	-.020	646	.186	589	.048
Business and Commercial	10.13	317	.160	310	.217	276	.132	11.18	530	.141	513	.224	492	.037
Chemistry	9.30	470	-.121	463	.029	426	-.015	10.39	286	-.018	281	.031	256	-.124
Drafting	7.69	414	-.030	399	.058	382	.083	Insufficient cases for analysis						
English	9.55	750	.004	739	.331	661	.301	10.69	680	.052	674	.206	614	.181
Electricity	8.10	103	.155	99	.111	91	-.062	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							11.30	90	-.186	87	.104	83	.147
Foreign Languages	9.75	447	-.044	440	.196	407	.191	10.85	410	.117	405	.221	367	.136
General Science	9.39	599	-.107	584	.074	526	-.079	10.62	510	-.146	469	.064	427	-.152
Health	8.46	220	-.080	213	-.018	186	.081	10.48	222	-.179	215	-.027	180	.073
Home Economics	Insufficient cases for analysis							12.44	427	.016	413	.187	389	.145
Mathematics	9.51	679	-.210	670	.138	623	-.042	10.49	508	-.030	498	.076	456	-.029
Music	10.10	341	.030	320	.277	305	.122	11.20	439	.024	420	.204	406	.096
Metals and Machines	7.12	109	-.178	104	.268	98	-.163	Insufficient cases for analysis						
Painting and Drawing	10.12	207	-.093	201	.247	182	-.080	11.16	289	.197	274	.238	262	.092
Physics	8.48	300	.061	296	-.002	266	-.039	9.56	62	.126	61	.006	51	-.161
Sales and Marketing	8.41	72	.108	71	-.145	65	-.021	10.34	115	.181	111	.066	108	.097
Social Studies	9.57	725	.026	705	.123	649	-.083	10.71	665	.096	648	.135	582	-.121
Woodworking	7.65	409	.009	394	.052	378	.040	Insufficient cases for analysis						

Table 66

Relationships of Garment Equipment Operation with School Courses (High School Seniors)

Test mean based on all 757 males is 3.82 Test mean based on all 681 females is 4.04

Course	Males							Females						
	Amount of Course Taken			Grade		Like-Dislike		Amount of Course Taken			Grade		Like-Dislike	
	Test Mean	N	r	N	r	N	r	Test Mean	N	r	N	r	N	r
Biology	3.90	678	.003	671	.124	617	.022	4.08	655	-.034	646	.190	589	.060
Business and Commercial	4.18	317	.144	310	.170	276	.103	4.31	530	.074	513	.198	492	.053
Chemistry	3.61	470	-.066	463	.057	426	.046	3.92	286	.005	281	.021	256	.138
Drafting	2.72	414	-.038	399	-.017	382	.060	Insufficient cases for analysis						
English	3.83	750	-.008	739	.261	661	.286	4.06	680	.042	674	.190	614	.194
Electricity	2.97	103	.282	99	.080	91	.042	Insufficient cases for analysis						
Food Preparation	Insufficient cases for analysis							4.69	90	-.161	87	-.050	83	.157
Foreign Languages	3.88	447	-.077	440	.147	407	.175	4.15	410	.130	405	.229	367	.166
General Science	3.70	599	-.098	584	.071	526	-.048	4.05	510	-.118	469	.086	427	-.129
Health	3.16	220	-.081	213	.021	186	.022	3.91	222	-.113	215	.057	180	.068
Home Economics	Insufficient cases for analysis							5.11	427	.079	413	.146	389	.129
Mathematics	3.75	679	-.220	670	.091	623	-.047	3.93	508	-.005	498	.144	456	-.010
Music	4.22	341	-.003	320	.233	305	.116	4.44	439	.059	420	.145	406	.174
Metals and Machines	2.48	109	-.079	104	.035	98	-.082	Insufficient cases for analysis						
Painting and Drawing	4.09	207	-.086	201	.169	182	-.041	4.27	289	.155	274	.175	262	.092
Physics	3.04	300	.103	296	-.020	266	-.057	3.39	62	.099	61	-.033	51	-.221
Sales and Marketing	2.92	72	.174	71	-.149	65	.028	3.65	115	-.002	111	.005	108	.115
Social Studies	3.84	725	.008	705	.096	649	-.070	4.07	665	.058	648	.117	582	-.104
Woodworking	2.73	409	.012	394	-.007	378	.039	Insufficient cases for analysis						

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